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ABSTRACT

This activity packet provides educators with a series of hands-on interdisciplinary classroom and outdoor education activities for grades 6-8 that focus on geology and prehistoric life at Cliffs of the Neuse State Park, North Carolina. The packet was designed to meet established curriculum objectives of the North Carolina Department of Public Instruction's Standard Course of Study. Three types of activities are included: (1) pre-visit classroom activities provide background and vocabulary development; (2) on-site activities conducted at the park; and (3) post-visit classroom activities to reinforce concepts, skills, and vocabulary. This learning experience exposes students to the major concepts of geologic processes, geologic time, and prehistoric life. The packet contains an introduction to Cliffs of the Neuse State Park; an activity summary; pre-visit, on-site, and post-visit activity objectives and instructions; a glossary; a list of 4 references; and a scheduling worksheet, program evaluation, and a parental permission form. (LZ)

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THE CLIFFS

OF TIME

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Cliffs of the Neuse State Park

An Environmental Education Learning Experience

Designed for Grades 6-8

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THE CLIFFS

OF TIME

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"It is important that you understand
our state's geologic history
because in one way or another
your life has been, and is,
affected by the events of the past.
Some of the effects are tangible, such
as water and mineral resources,
the character of the soil,
or the shape of the land.
But in more intangible terms,
understanding the earth's past
can help us as we strive to
understand man's relation to time
and the planet on which we live."

- Fred Beyer,
North Carolina -
The Years Before Man.

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CP&L

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was developed by

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Cliffs of the Neuse State Park

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Table of Contents

1. Introduction
- Introduction to the North Carolina State Parks System 1.1
- Introduction to Cliffs of the Neuse State Park 1.2
- Introduction to the Activity Packet for Cliffs of the Neuse State Park 1.5
- Introduction to the Geology of Cliffs of the Neuse State Park 1.6

2. Activity Summary 2.1

3. Pre-Visit Activity
- #1 A Key to Time 3.1

4. On-Site Activity
- #1 A Line Through Time 4.1

5. Post-Visit Activity
- #1 Life at the Cliffs, Then and Now 5.1

6. Vocabulary 6.1

7. References 7.1

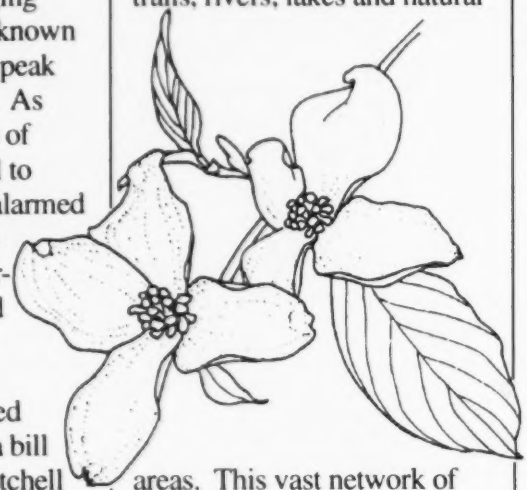
8. Forms 8.1

9. Notes 9.1

Introduction to the North Carolina State Parks System

Preserving and protecting North Carolina's natural resources is actually a relatively new idea. The seeds of the conservation movement were planted early in the 20th century when citizens were alerted to the devastation of Mount Mitchell. Logging was destroying a well-known landmark - the highest peak east of the Mississippi. As the magnificent forests of this mile-high peak fell to the lumbermen's axe, alarmed citizens began to voice their objections. Governor Locke Craig joined them in their efforts to save Mount Mitchell. Together they convinced the legislature to pass a bill establishing Mount Mitchell as the first state park of North Carolina. That was in 1915.

The North Carolina State Parks System has now been established for more than three quarters of a century. What started out as one small plot of public land has grown into 59 properties across the state, including parks, recreation areas, trails, rivers, lakes and natural areas. This vast network of land boasts some of the most beautiful scenery in the world and offers endless recreation opportunities. But our state parks system offers much more than scenery and recreation. Our lands and waters contain unique and valuable archaeological, geological and biological resources that are important parts of our natural heritage.



As one of North Carolina's principal conservation agencies, the Division of Parks and Recreation is responsible for the more than 125,000 acres that make up our state parks system. The Division manages these resources for the safe enjoyment of the public and protects and preserves them as a part of the heritage we will pass on to generations to come.

An important component of our stewardship of these lands is education. Through our interpretation and environmental education services, the Division of Parks and Recreation strives to offer enlightening programs which lead to an understanding and appreciation of our natural resources. The goal of our environmental education program is to generate an awareness in all individuals which cultivates responsible stewardship of the earth.

For more information contact:

N.C. Division of Parks and Recreation
P.O. Box 27687
Raleigh, NC 27611-7687
919/ 733-4181

Introduction to Cliffs of the Neuse State Park

Efforts to establish Cliffs of the Neuse State Park began in 1944, when Lionel Weil proposed that the cliffs area along the Neuse River be preserved as a state park. Weil and other individuals donated land through the Wayne Foundation, and the park was established in 1945. Today the park encompasses 748 acres.

The Cliffs:

Extending 600 feet, and rising 90 feet above the Neuse River, the cliffs of the Neuse were formed millions of years ago when a fault in the Earth's crust shifted. The Neuse River followed this fault line and, over time, cut its course through layers of sediment deposited by shallow seas that had earlier covered the coastal plain. A portion of the river took a bend and the water's erosive force slowly carved the cliffs of the Neuse.

The cliffs of the Neuse tell a lot about the area's geologic history. Layers of sand, clay, seashells, shale and gravel form the multi-colored cliff face, with each layer containing clues as to what life may have been like millions of years ago.

History Highlights:

Much of the human history of the area centers around the river. Native Americans of the Tuscarora and Saponi tribes once occupied much of the land between the Neuse and Pamlico rivers. What is now the park was a ceremonial ground and a gathering place for hunting expeditions. The river served as an avenue for travel into the surrounding wilderness. Early European settlers set up a trading center at Whitehall (now Seven Springs), the earliest English settlement in the area. After the Revolutionary War, a stagecoach line as well as river traffic promoted the growth of this agricultural town.

Early in the twentieth century, Whitehall was known for its mineral water cures. In an area of just a few square feet were seven springs, each said to produce water with a different chemical content. On summer weekends, visitors checked into local hotels to drink the mineral water and take riverboat excursions to the cliffs. A gallon a day of the springs' water was prescribed for "whatever-ails-you."

The waters were also used in whiskey stills. Local philosophers declared that if mineral water would not cure people's ills, then corn whiskey would make them forget what ailed them. In the 1920s, the thriving community was damaged by fire and it never fully recovered.

Natural History Highlights:

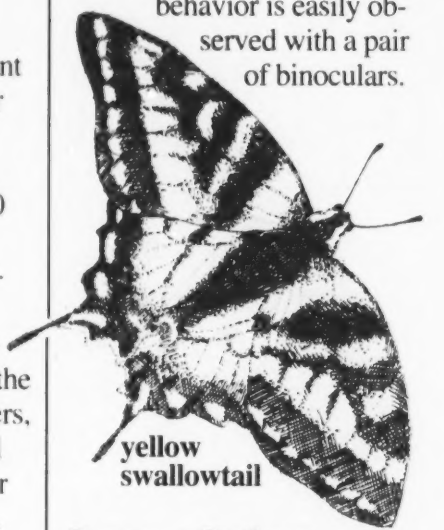
Plants

A range of habitats contributes to the abundance and variety of plants in the park. River margins, flood plains, rolling uplands and ravines are home to an unusual mixture of trees, shrubs and herbaceous plants. More than 420 species of plants have been recorded here. At least five plant communities can be observed in the park, each with its own unique characteristics. Spanish moss reaches its westernmost limit of distribution here. Galax, a common plant in the mountains, is abundant on moist, well-drained slopes. Two trees, red oak and Virginia pine, typically found in the western part of the state, grow within sight of coastal plain trees like cypress and live oak. Wild azalea, trailing arbutis and pink ladyslippers are just a few of the park's common flowering plants.

Wildlife

The mixture of varied plant communities next to a major coastal plain river creates numerous wildlife habitats. The river hosts more than 50 species of fish, such as the lognose gar, and several species of freshwater mussels. Many different kinds of reptiles and amphibians live in the park. Mammals such as otters, muskrats, beavers, mink and raccoons hunt along the river and small creeks in the park. Birds are well represented, with approximately 160 species that can be seen throughout the year.

Look for waterfowl and shore birds at the park lake. Listen for barred owls and whip-poor-wills at night in the summer. Scan the skies above the river near the cliffs for soaring raptors—with luck you may spot a bald eagle. During the migration season, take a hike along one of the four hiking trails to look for warblers and other migratory birds. Keep an eye out for deer and fox squirrels. Though not as conspicuous as the larger animals, butterflies and dragonflies are abundant and their behavior is easily observed with a pair of binoculars.



yellow swallowtail

Program Options:

Cliffs of the Neuse State Park has many cultural and natural history themes and is an excellent place to teach them. The exposed surface of the cliffs provides an outdoor classroom in which to explore the geologic history of the area. Groups are encouraged to visit the park during all seasons of the year for hikes, exploration, nature study and other activities. Leaders may choose to design and conduct their own activities or to use this Environmental Education Learning Experience activity packet. A

belted kingfisher

park ranger will be happy to assist you with your programming needs. Park staff will make every effort to accommodate persons with disabilities.

Scheduling a Trip:

1. Please contact the park at least two weeks in advance to make a reservation.

2. Complete the Scheduling Worksheet located on page 8.1, and return it to the park as soon as possible.

3. Research activity permits may be required for sampling activities. If your group plans to collect any plant, animal or mineral within the park, please contact the park office at least 30 days in advance to obtain a permit application.

4. The usual fees for activities, such as boat rental and swimming, will apply.

Before the Trip:

1. Complete the pre-visit activity in the Environmental Education Learning Experience packet.

2. The group leader should visit the park without the participants prior to the group trip. This will enable you to become familiar with the facilities and park staff, and to identify any potential problems.

3. The group leader should discuss park rules and behavior expectations with adult leaders and participants. Safety should be stressed.

4. Inform the group about poison ivy, ticks, snakes and insects. Suggest the use of insect repellent from late spring through early fall.

5. Everyone should wear a name tag. Please color-code tags (for groups) and establish a buddy system.

6. Activities that take place outdoors may expose participants to insects and seasonal weather conditions. Be prepared by dressing accordingly and wearing sunscreen or insect repellent, if necessary. Comfortable walking shoes should also be worn.

7. *The group leader is responsible for obtaining a parental permission form from each participant, including a list of any health considerations and medical needs.* An example of this form is on page 8.2.

8. *If you will be late or need to cancel your trip, please notify the park as far ahead of time as possible.*

While at the Park:

Please obey the following rules:

1. To help you get the most out of the experience and increase your chance of observing wildlife, be as quiet as possible while in the park.

2. On hikes, walk behind the leader at all times. Running, climbing and horseplay are not permitted. Please stay on the trails!

3. All plants and animals within the park are protected. Injuring or removing plants and harming animals are prohibited in all state parks. This allows future visitors the same opportunity to enjoy our natural resources.

4. Picnic in designated picnic areas only. Help keep the park clean and natural; do not litter.

5. In case of accident or emergency, contact park staff immediately.

Following the Trip:

1. Complete the post-visit activity in the Environmental Education Learning Experience packet.

2. Build upon the field experience and encourage participants to seek answers to questions and problems encountered at the park.

3. Relate the experience to classroom activities and curriculum through reports, projects, demonstrations, displays and presentations.

4. Give tests or evaluations, if appropriate, to determine if students have gained the desired information from the experience.

5. File a written evaluation of the experience with the park. Evaluation forms are available in the activity packet on page 8.3.

Park Information:

Address:

Cliffs of the Neuse State Park
345 A Park Entrance Rd.
Seven Springs, NC 28578
Tel: (919) 778-6234
Fax: (919) 778-9589

Office Hours:

Year-round,
Mon - Fri 8:00 am -5:00 pm

Hours of Operation:

Nov - Feb	8:00am-6:00pm
Mar, Oct	8:00am-7:00pm
Apr,May,Sep	8:00am-8:00pm
Jun - Aug	8:00am-9:00pm

Introduction to the Activity Packet for Cliffs of the Neuse State Park

The Environmental Education Learning Experience, *Cliffs of Time*, was developed to provide environmental education through a series of hands-on activities for the classroom and the outdoor setting of Cliffs of the Neuse State Park. This activity packet, designed for grades 6 through 8, meets established curriculum objectives of the North Carolina Department of Public Instruction's Standard Course of Study. Three types of activities are included:

1) pre-visit activity
2) on-site activity
3) post-visit activity

The on-site activity will be conducted at the park, while pre-visit and post-visit activities are designed for the classroom. Pre-visit activities should be introduced prior to the park visit so that students will have the necessary background and vocabulary for the on-site activities. We encourage you to use the post-visit activities to reinforce concepts, skills and vocabulary learned in the pre-visit and on-site activities. These activities may be performed independently, but have been designed to be done in a series to build upon the students' newly gained knowledge and experiences.

The Environmental Education Learning Experience, *Cliffs of Time*, will expose the students to the following major concepts:

- **Geologic Processes**
- **Geologic Time**
- **Prehistoric Life**

The first occurrence of vocabulary words used in these activities is indicated in **bold type**. Their definitions are listed in the back of the activity packet. A list of the reference materials used in developing the activities follows the vocabulary list.

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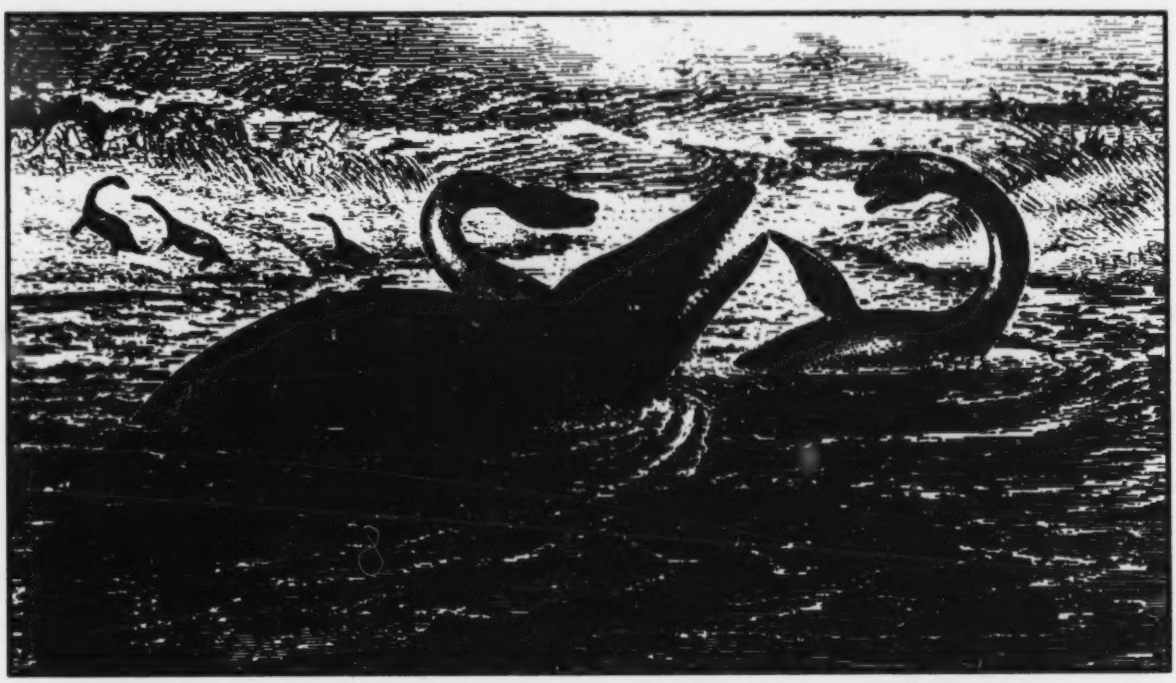
Note:
The on-site activity will require hiking which could expose the students to hot or cold conditions and ticks and other insects. Accessibility to some of these areas may be difficult for persons with disabilities. When conducting the on-site activity, please remember that collecting specimens of any kind in the park is prohibited.

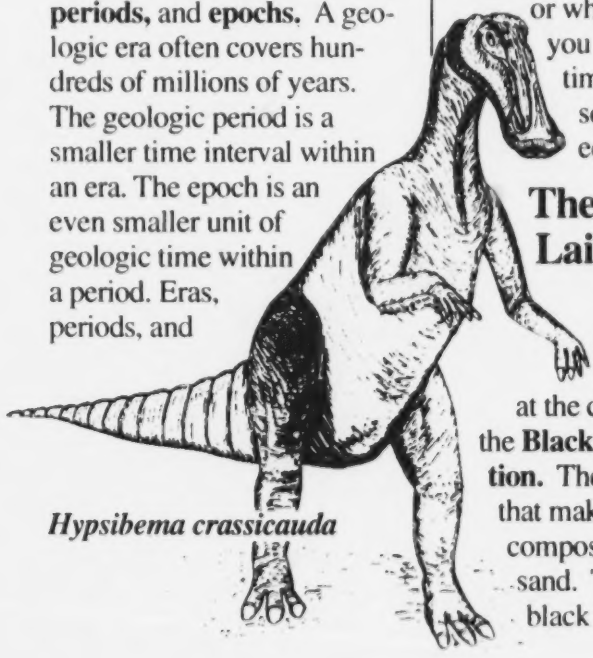


Introduction to the Geology of Cliffs of the Neuse State Park

Geology &Geologic Time

Geology is the scientific study of the origin, history and structure of the earth. **Geologists** estimate that the Earth is approximately 4.6 billion years old! A billion is a 1, followed by nine zeros. That's a lot of zeros. If someone had a billion dollars to give you and gave you a dollar each day, you would never see the entire billion; you would probably only get about 27,000 dollars before you passed away. Another way of looking at it is 4.6 billion is 4,600 million. This amount of time is so great that it is hard to comprehend. Geologists refer to this as **geologic time**.

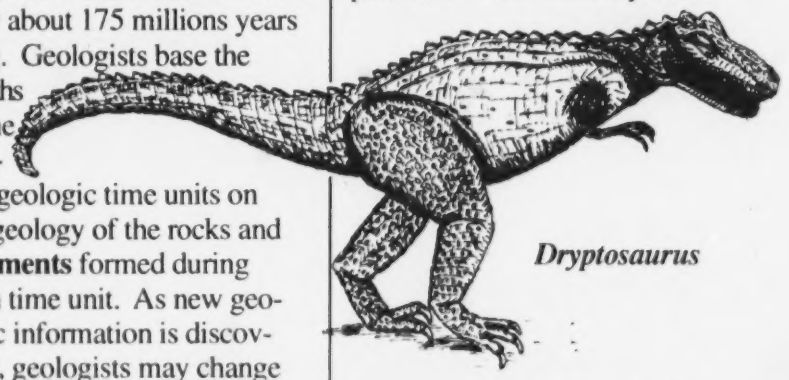
Geologic time is divided into segments called **eras, periods,** and **epochs.** A geologic era often covers hundreds of millions of years. The geologic period is a smaller time interval within an era. The epoch is an even smaller unit of geologic time within a period. Eras, periods, and epochs are not like our standard time units of hours, minutes, and seconds. Unlike our standard time units, geologic time units can vary in length. For example, the Paleozoic era is about 350 million years long while the Mesozoic era is only about 175 millions years long. Geologists base the lengths of the various geologic time units on the geology of the rocks and **sediments** formed during each time unit. As new geologic information is discovered, geologists may change their estimates for the lengths of some geologic time units. This is why different textbooks do not always agree on the length of a particular geologic time period, when it started or when it ended. When you study geologic time, remember that scientific knowledge is tentative!



Hypsibema crassicauda

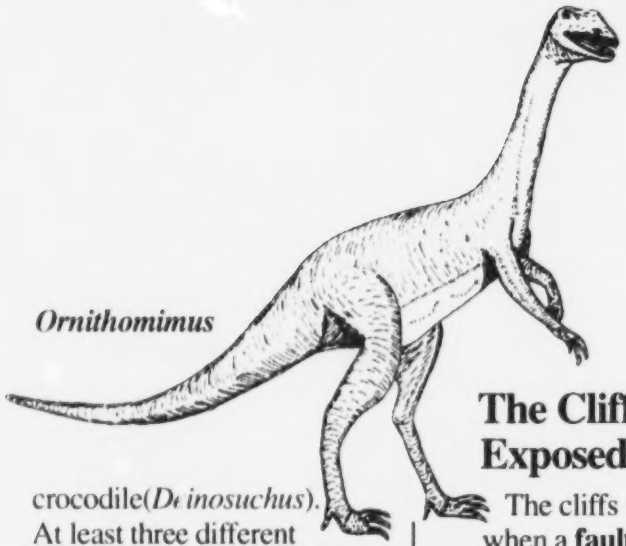
The Layers Are Laid

The specific geologic formation exposed today at the cliffs is known as the **Black Creek Formation.** The layers, or beds, that make up the cliffs are composed of clays and sand. The dark gray to black layers are clays, probably deposited in a tidal marsh. The white to yellowish layers are made of sand and indicate the location of an old ocean beach. Most geologists agree that the layers were deposited during the Cretaceous period, over 66 million years ago (**mya**). The layers in the cliffs provide evidence that the sea level rose and fell many times, rearranging the coastline. Some geologists think that rivers and streams, carrying eroded sediments to the sea, may have formed large marshy **deltas** in the **coastal plain.**



Dryptosaurus

The Black Creek Formation contains fossils that give geologists clues as to the specific animals and plants that lived in the gently rolling piedmont and coastal plain during Cretaceous time. Fossil shells and animal burrows help us identify the marine invertebrates that lived in the estuaries and ocean at that time. Fossil teeth and bone fragments indicate the presence of sharks, bony fish, aquatic turtles, and a giant



Ornithomimus

crocodile(*Deinosuchus*). At least three different kinds of dinosaurs probably lived in the area a duckbilled dinosaur (*Hypsibema*), an ostrich-like coelurosaur (*Ornithomimus*), and a relative of *Tyrannosaurus rex* (*Dryptosaurus*). Looking at fossil evidence from other parts of the United States, geologists think it is likely that pterosaurs, the flying reptiles, filled the Carolina skies while the mosasaurs, 29 foot-long marine lizards, hunted in our coastal waters. Bees, butterflies and flowering plants also developed during this time.

The Cliffs Are Exposed

The cliffs were formed when a **fault** in the Earth's crust shifted millions of years ago. The Neuse River followed this fault line and, over time, cut its course through layers of sediment deposited by the shallow seas that had earlier covered the coastal plain.

mosasaur

A portion of the river took a bend and the water's erosive force slowly carved the cliffs of the Neuse. Today, the cliffs rise over 90 feet above the river's surface.

Activity Summary

The following outline provides a brief summary of each activity, the major concepts introduced and the objectives met by completion of the activity.

I. Pre-Visit Activity

#1 A Key To Time (page 3.1.1)

This pre-visit activity, designed for the classroom, will introduce the concept of geologic time and some significant events that occurred in our area.

Major concepts:

- Geologic time
- Geologic history
- Prehistoric life
- Use of a key

Objectives:

- List the three major divisions of geologic time.
- List the five eras of geologic time.
- Name the present period and epoch.
- Define a key.
- Use a simple key to identify eras, periods and epochs.

II. On-Site Activity

#1 A Line Through Time (page 4.1.1)

This activity is designed to allow the students to be the teachers. They will relate how the cliffs were formed, and highlight plants, animal and significant events from the Mesozoic Era to the present. They will be provided with instructions and props to illustrate specific points.

Major Concepts:

- Geologic time
- Formation of the cliffs of the Neuse
- Prehistoric life

Objectives:

- Name two eras that are represented in the cliffs.
- Name the formation that makes up most of the layers of the cliffs.
- List three animals and three plants that existed during the formation of the cliffs' layers.
- Describe the basic geologic process that formed the cliffs.

III. Post-Visit Activity

#1 Life at the Cliffs, Then and Now (page 5.1.1)

Students will complete a word search containing vocabulary words and the names of plants and animals from the past and present. Some of the words will be new so the students can be assigned specific ones to increase their vocabulary. The concept of why the park was created will also be introduced.

Major concepts:

- Geologic terms
- Plants and animals
- Conservation and stewardship

Objectives:

- Become familiar with geologic terms and plant and animal names that are pertinent to Cliffs of the Neuse State Park.
- Explain why Cliffs of the Neuse was set aside as a state park.
- List two unique geological features, two unique plants, and two unique animals that exist within the park boundaries.

duckbilled dinosaur
(Hypsibema crassicauda)

17

Pre-Visit Activity #1 — A Key to Time

Curriculum Objectives:

Grade 6
- Communication Skills: listening, reading, vocabulary and reading comprehension, study skills using environmental sources
- Guidance: competency for interacting with others
- Social Studies: gather, organize and analyze information, draw conclusions
- Science: nature of science, classifying, origin of rocks and change with time

Grade 7
- Communication Skills: listening, reading, vocabulary and viewing comprehension, study skills using environmental sources
- Guidance: being responsible in a group
- Science: nature of science, classifying, climate change

Grade 8
- Communication Skills: listening, reading, vocabulary and viewing comprehension, study skills using environmental sources
- Guidance: being responsible in a group
- Science: nature of science, classifying, geologic time, evolution, adaptation

Location: Classroom

Group Size:
30 students, class size

Estimated Time:
One to two class periods

Appropriate Season: Any

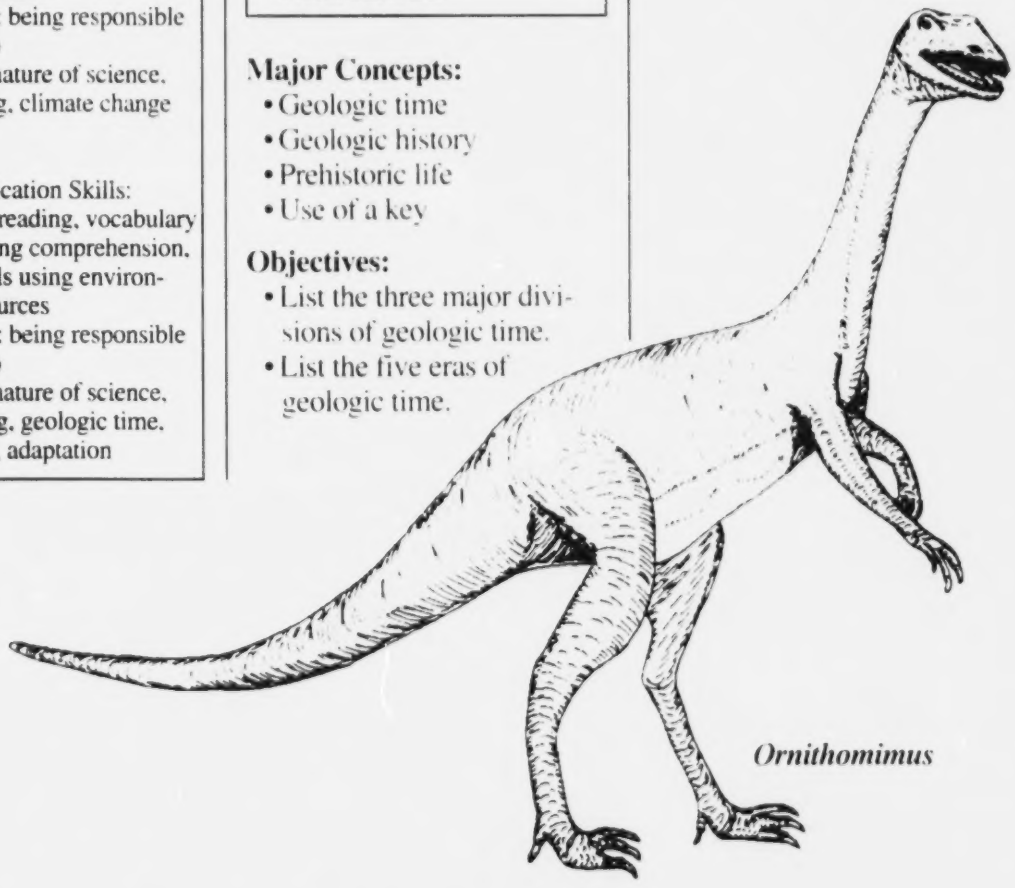
Materials:
Provided by the educator:
Per student: "Introduction to the Geology of Cliffs of the Neuse State Park"
Per Two Students: Student's Information, "A Key to Geologic Time," one set of "Clue Cards to Time" and "Geologic Time Worksheet". Optional: "Geologic Time Scale for North Carolina"

Major Concepts:
- Geologic time
- Geologic history
- Prehistoric life
- Use of a key

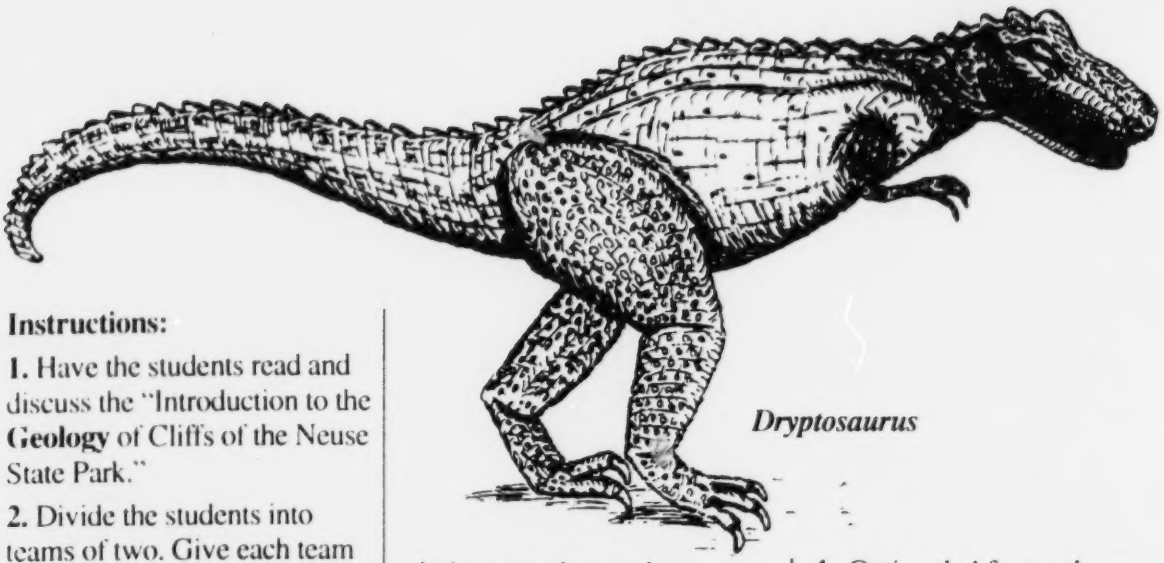
Objectives:
- List the three major divisions of geologic time.
- List the five eras of geologic time.
- Name the present period and epoch.
- Define a key.
- Use a simple key to identify eras, periods and epochs.

Educator's Information:

This activity is designed to introduce the concept of **geologic time** through the use of a simple **key**. The students will use a simple key to identify geologic time intervals and learn some of the significant events that occurred during each.



Ornithomimus



Dryptosaurus

Instructions:

1. Have the students read and discuss the "Introduction to the **Geology** of Cliffs of the Neuse State Park."

2. Divide the students into teams of two. Give each team one copy of the following: Student's Information, "A Key to Time," and the "Clue Cards to Time." Each team should separate the "Clue Cards to Time" by cutting along the dotted lines. They should also shuffle the cards before beginning the activity.

3. Using the Student's Information, explain what a key is and how it works. Ask each team to pick a card and read it. Then, start at the top of "A Key to Time" to identify the geologic time interval described on their card. Emphasize that the students are to work as a team, making logical choices together as they come to each branch of the key. When they have found the name for the time interval described on their card, they should write their answer on the "Geologic Time Worksheet" next to the letter that matches the letter on the card. For example, if the students "key out" Clue Card A as the Devonian period, they should write the word Devonian on line A of the "Geologic Time Worksheet." When they finish with all their cards, they will have arranged the **eras**, **periods**, and **epochs** in their proper chronological order on the worksheet.

4. Optional: After each team has finished, give them a copy of the "Geologic Time Scale for North Carolina." Using this time scale, the students should write the time span next to each era and each period on their worksheets. For example, according to the time scale, the Devonian period began 410 mya and ended, at the beginning of the Mississippian period, 360 mya. Next to the Devonian period on their worksheets, the students should write "360-410 mya." An answer sheet has been provided for the teacher.

Student's Information

Geologic time, the **eras**, **periods** and **epochs** covering hundreds, even thousands of millions of years, can be confusing and complicated. Using a **key** will help you become familiar with geologic time. To find out what a key is, read on!

Keys:

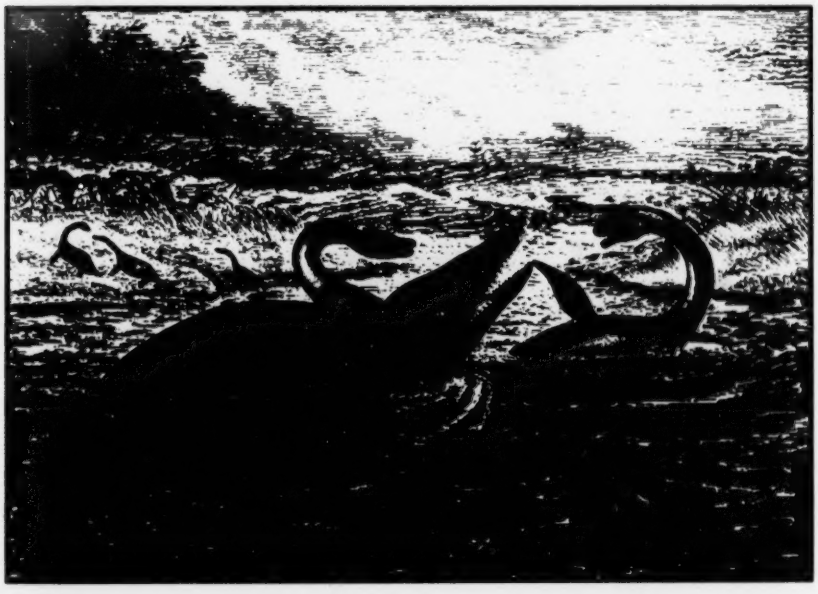
A key is an essential tool used by people to help them identify or classify plants, animals, rocks and many other things. In our case, we will use a key to identify geologic time intervals. Always start at the beginning, or top, of a key and work your way down, step by step. If you make the best choice at each branch of the key, you should be successful in finding the correct name for your specific plant, rock, or geologic time interval. Once you learn how to use a key, it is usually the fastest and most accurate way to identify things. However, you must be a good observer and a careful reader who pays attention to details.

How to use the "Key to Geologic Time":

It takes time to learn how to read a key. Read slowly and work with your partner. First, carefully read a Clue Card which describes the significant characteristics of a particular geologic time interval. Then, begin at the top of the key. You are given two choices: either the interval is an era, or it is <u>not</u> an era. If the description on the card tells you that the interval <u>is</u> an era, continue down the right branch of the key. Here you must pick from five choices. Choose the name of the era that best matches the interval described on your Clue Card. Then, write the era name on the "Geologic Time Worksheet" next to the letter that corresponds to the letter on your Clue Card.

What if you decide that the geologic time interval described on your Clue Card is <u>not</u> an era? In this case, you continue down the left branch of the key where you must choose between epoch and period. After making this choice, you have to make more choices to find the correct name of your epoch or period. Again, write the name of the interval on your worksheet next to the letter that matches the letter on your Clue Card. Go on to the next card. When you have completed all the cards, check your answers with your teacher. If you made a mistake, go back to the key and try to determine where you made an incorrect choice.

Plesiosaurus & Ichthyosaurus



Geologic Time Scale For North Carolina

EON	ERA	PERIOD	EPOCH	GEOLOGIC EVENTS	AGE*
PHANEROZOIC	CENOZOIC	Quaternary	Holocene	Deposition of sediments in Coastal Plain. Erosion of Piedmont and Appalachian Mountains to their present rugged features.	1.7
			Pleistocene		
		Tertiary	Pliocene		5
			Miocene	Phosphate deposited in eastern North Carolina (Beaufort and Pamlico Counties).	24
			Oligocene	Limestone deposited in Coastal Plain. Weathering and erosion continue in Piedmont and Mountains.	66
			Eocene		
			Palcocene		
	MESOZOIC	Cretaceous	Late	Deposition of estuarine and marine sediments the Coastal Plain. Continued erosion of the Piedmont and Mountains	138
			Early	Sediments deposited in northern half of the Coastal Plain. Cape Fear Arch begins to develop. Piedmont and Mountains eroded.	
		Jurassic	Late	Marine sediments deposited on outer continental shelf. Piedmont and mountains eroded.	205
			Middle	Weathering and erosion of the Blue Ridge and the Piedmont areas. Emplacement of diabase dikes and sheets.	
			Early		
		Triassic	Late	Faulting and rifting creates Deep River, Dan River, and Davie basins. Basins fill with continental clastic sediments known as "red beds".	240
			Middle	Formation of the Atlantic Ocean as North America and Africa drifted apart. Weathering and erosion of Piedmont and Mountains.	
			Early		
	PALEOZOIC	Permian		Final collision of North America and Africa. Thrust faulting in west; deformation in eastern Piedmont.	290
		Pennsylvanian		Emplacement of igneous intrusions: Time of uplift and erosion.	330
		Mississippian		Time of uplift and erosion.	360
		Devonian		Emplacement of lithium, mica, and feldspar-rich pegmatites, primarily in the Kings Mountain and Spruce Pine districts. Metamorphism of Carolina slate belt. Period of erosion.	410
		Silurian		Period of uplift and erosion.	435
		Ordovician		Continental collision and beginning of mountain building process—faulting, folding, and metamorphism of pre-existing rocks.	500
		Cambrian		Sandstone, shale, and limestone deposited in the mountain area. Continued deposition of Carolina slate belt rocks. Gold deposits of the slate belt form	570
PRECAMBRIAN	PROTEROZOIC	Late		Sedimentary and volcanic rocks deposited in the mountains and Piedmont. Local intrusions of igneous rocks.	900
		Middle		Sedimentary, volcanic, and igneous rocks formed in the Blue Ridge and metamorphosed to gneisses and schists.	1,600
		Early		Oldest dated rock in North Carolina is 1,800 million years old.	2,500
	ARCHEOZOIC			Oldest known rock in U.S. is 3,600 million years. Oldest known rocks in world are 3,850 million years. Formation of the Earth was 4,500 million years ago.	4,000+

* estimated age in millions of years

Adapted from: NC Geological Survey, Bulletin 91

Clue Cards to Time

A. This era represents the longest division of Earth's history, from the time the Earth was formed, 4,500 mya to 2,500 mya. The earliest fossil records date back to 3,400 mya. This era contains no periods.

B. The collision of different island arcs and land masses produced a major mountain building event during this era.

C. There were at least four glacial advances during this epoch, which occurred in the Quaternary Period. Wooly mammoths, mastodons and wooly rhinoceroses were common during these glacial advances. Most notable was the appearance of *Homo sapiens*.

D. Both the first dinosaurs and the first small, mouse-like mammals appeared near the end of this period, that occurred during the Mesozoic Era.

E. This period occurred in the Paleozoic Era. Marine invertebrates specialized and a primitive tree, the ginkgo, appeared. This period ended with a severe mass extinction of 96% of all species.

F. This epoch occurred during the Tertiary period. The oceans receded and exposed much more land to erosional forces. Mammals were becoming common on land and sharks were abundant in the oceans.

G. Known as "The Age of Reptiles," because reptiles dominated the air, land and sea. This era contains three periods.

H. Fossil records indicate the presence of saber-toothed cats during this epoch. Elephants, apes, monkeys, giraffes and cattle are some of the mammals that evolved during this epoch, which occurred during the Tertiary period.

I. Known as "The Age of Ancient Life," this era marked the first appearance of shelled animals. The most common one was the trilobite. This era is divided into seven periods.

J. Although this era is the shortest era, it contains the most complete geologic record of the Earth's history. This era is often referred to as the "Time of Recent Life."

K. All life lived in the ocean during this period. The Earth's atmosphere did not block ultraviolet radiation from the sun. Primitive sponges, marine invertebrates and shellfish were common at this time. This period occurred during the Paleozoic Era.

L. Sharks, rays and bony fishes multiplied and diversified during this period. This period occurred during the Paleozoic Era.

Clue Cards to Time

M. During this period, North America was covered by water. Plant-like marine invertebrates such as feather stars and sea lilies flourished in the oceans. This period occurred during the Paleozoic Era.

S. Pterosaurs, the flying reptiles, lived during this period and the first birds evolved. This period's name was part of a title of a famous movie. This period occurred during the Mesozoic Era.

N. The climate of this epoch, during the Quaternary period, is much warmer than the climate of the Ice Ages. Humans are playing a greater role in the extinction of both plants and animals in this epoch.

T. Major mountain building and the evolution of insects and reptiles were significant events during this period. The largest dragonfly to ever live was zipping around on wings that measured 29 inches! This period occurred during the Paleozoic Era.

O. Most life forms were still evolving in the oceans during this period. Oysters, clams, starfish and hard corals were developing. Very primitive jawless fish appeared during this period, which occurred during the Paleozoic Era.

U. During this period, many different types of mammals developed. This period contains five epochs and belongs in the Cenozoic Era.

P. Tyrannosaurs and duckbilled dinosaurs were alive during this period. Flowering plants, bees and butterflies evolved during this time. The end of this period saw the extinction of all dinosaurs. This period occurred during the Mesozoic Era.

V. No new major life forms developed during this period, with the exception of extensive coral reefs in shallow areas of oceans. This period belongs in the Paleozoic Era.

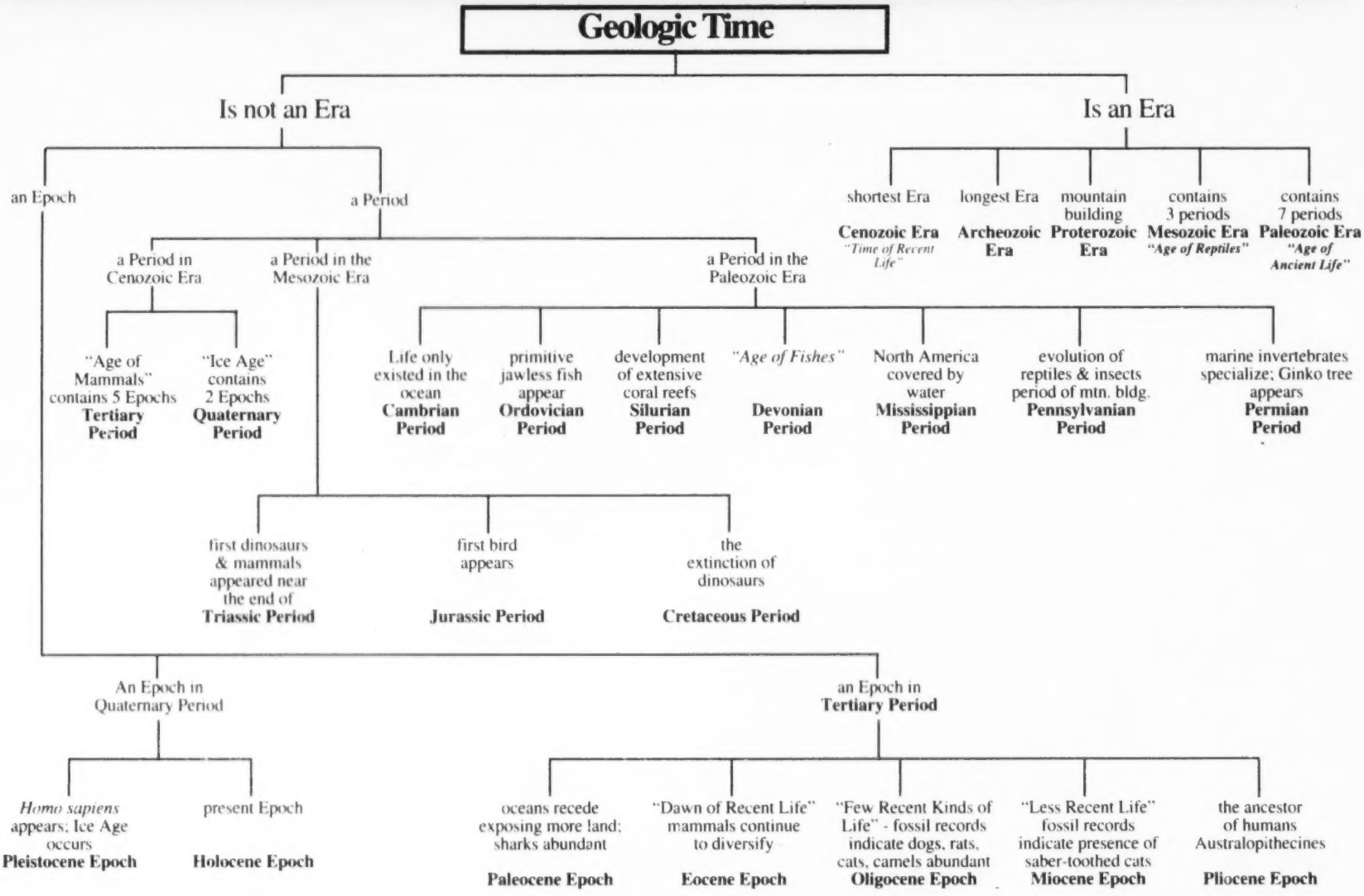
Q. Fossil records indicate that dogs, cats, rats and camels were alive during this epoch. The name of this epoch means "Few Recent Kinds of Life." This epoch occurred during the Tertiary period.

W. Australopithecines, ancestors to humans, evolved during this epoch, which belongs in the Tertiary Period.

R. The early part of this period was dominated by the Ice Ages and is divided into two epochs. This period occurred during the Cenozoic Era.

X. The name of this epoch means "Dawn of Recent Life." Mammals continued to multiply and diversify during this epoch. This epoch belongs to the Tertiary Period.

A Key to Time



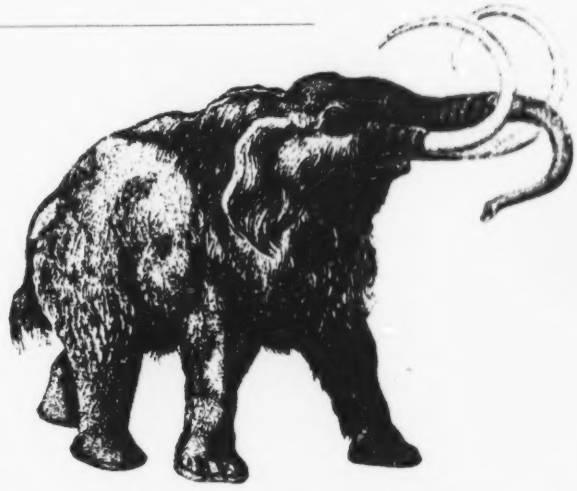
September 1994 3.1.7 Cliffs of the Neuse State Park, NC

Geologic Time Worksheet

Eras	Periods	Epochs
J.	R.	N.
		C.
	U.	W.
		H.
		Q.
		X.
		F.
G.	P.	
	S.	
	D.	
I.	E.	
	T.	
	M.	
	L.	
	V.	
	O.	
	K.	

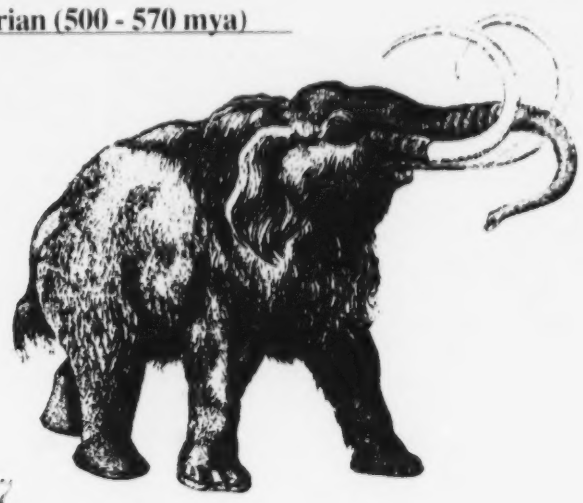
B. _____

A. _____



Geologic Time Answer Sheet

Eras	Periods	Epochs
J. Cenozoic (present-66 mya)	R. Quaternary (present - 1.7 mya)	N. Holocene
		C. Pleistocene
	U. Tertiary (1.7 - 66 mya)	W. Pliocene
		H. Miocene
		Q. Oligocene
		X. Eocene
		F. Paleocene
G. Mesozoic (66 - 240 mya)	P. Cretaceous (66 - 138 mya)	
	S. Jurassic (138 - 205 mya)	
	D. Triassic (205 - 240 mya)	
I. Paleozoic (240 - 570 mya)	E. Permian (240 - 290 mya)	
	T. Pennsylvanian (290 - 330 mya)	
	M. Mississippian (330 - 360 mya)	
	L. Devonian (360 - 410 mya)	
	V. Silurian (410 - 435 mya)	
	O. Ordovician (435 - 500 mya)	
	K. Cambrian (500 - 570 mya)	
B. Proterozoic (570 - 2,500 mya)		
A. Archeozoic (2,500 - 4,000 mya)		



27

On-Site Activity #1 — A Line Through Time

Curriculum Objectives:

Grade 6
- Communication Skills: listening, reading, vocabulary and viewing comprehension, study skills using environmental sources, speaking techniques
- Guidance: competency for interacting with others
- Social Studies: gather, organize and analyze information, draw conclusions
- Science: nautre of science, rocks and geologic profiles

Grade 7
- Communication Skills: listening, reading, vocabulary and viewing comprehension, study skills using environmental sources, speaking techniques
- Guidance: being responsible in a group
- Science: organization and variety of living things, Earth science
- Social Studies: gather, organize and analyze information, draw conclusions
- Science: nature of science, climate changes over time

Grade 8
- Communication Skills: listening, reading, vocabulary and viewing comprehension, study skills using environmental sources, speaking techniques
- Guidance: being responsible in a group
- Science: organization and variety of living things, Earth science
- Social Studies: gather, organize and analyze information, draw conclusions
- Science: nature of science, change in landforms and life forms through geologic time, adaptation and evolution

Location: 350 Yard Trail

Group Size:
Maximum 30 students

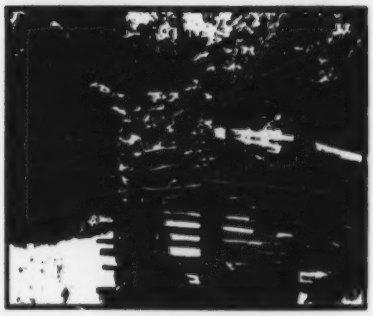
Estimated Time: 1 - 2 hours

Appropriate Season: Any

Materials:
Provided by the educator:
Per student: Student's Information sheet
Per group: Layers of Time Information Cards
Provided by the Park:
Per group: Cliffs Model, Cenozoic Kit, Mesozoic Kit, 90-foot ropes

Major Concepts:
- Geologic time
- Formation of the cliffs of the Neuse
- Prehistoric life

Objectives:
- Name two eras of time that are represented in the cliffs.
- Name the formation that makes up most of the layers of the cliffs.
- List three animals and three plants that existed during the formation of the cliffs' layers.
- Describe the basic geologic process that formed the cliffs.



Educator's Information:

In this activity the students will learn how the layers in the cliffs were formed through **sedimentation**. They will also discuss the time span in which this process took place and how it is still taking place today. They will review the concept of geologic time, and learn about the plants and animals that existed during the Mesozoic and Cenozoic **eras**.

The students will be split into two groups. Each group will have a 90-foot rope that will represent the cliff. The rope will be marked to represent layers and places where the students will stop. At each stop they will use props and "Layers of Time Information Cards" to explain the significant events that occurred during that particular time period. They will add a "layer" or an appropriate animal or plant that lived during that **geologic time period** to the Cliffs Model at the end of each stop. By the end of the activity the students will have built a representative model of the cliffs.

Instructions:

Prior to your visit:

Students should read and discuss the Student's Information sheet. Divide the class into two groups. Make two copies of each of the "Layers of Time Information Cards" and give each group one entire set of cards. If you have fewer than 15 students per group, some of the students will need two cards. If you have more than 15 students, assign one card per two students as needed.

Have the students put their names at the top of their cards and discuss with them what they will be doing at the park. Have them read through their cards so that they will be familiar with their topics before they come to the park. The students may have trouble pronouncing or reading some of the words on their cards. (The rangers have the same problem!) Using the pronunciation guides on the cards, work through the unfamiliar words with the students to avoid difficulties or embarrassments during their presentations. Encourage students to add any information, props, or ideas of their own that will make their presentation better. The main goal is to have fun and learn something in the process.

Be sure to collect their "Layers of Time Information Cards" and keep them until the visit to the park, when the cards will be handed out again.

At the Park:

1. Divide the class into the two groups. Each group should have a ranger or educator with them. Each group will receive a **Mesozoic** Kit, **Cenozoic** Kit, 15 "Layers of Time Information Cards," one Cliffs Model and one 90-foot rope. Each

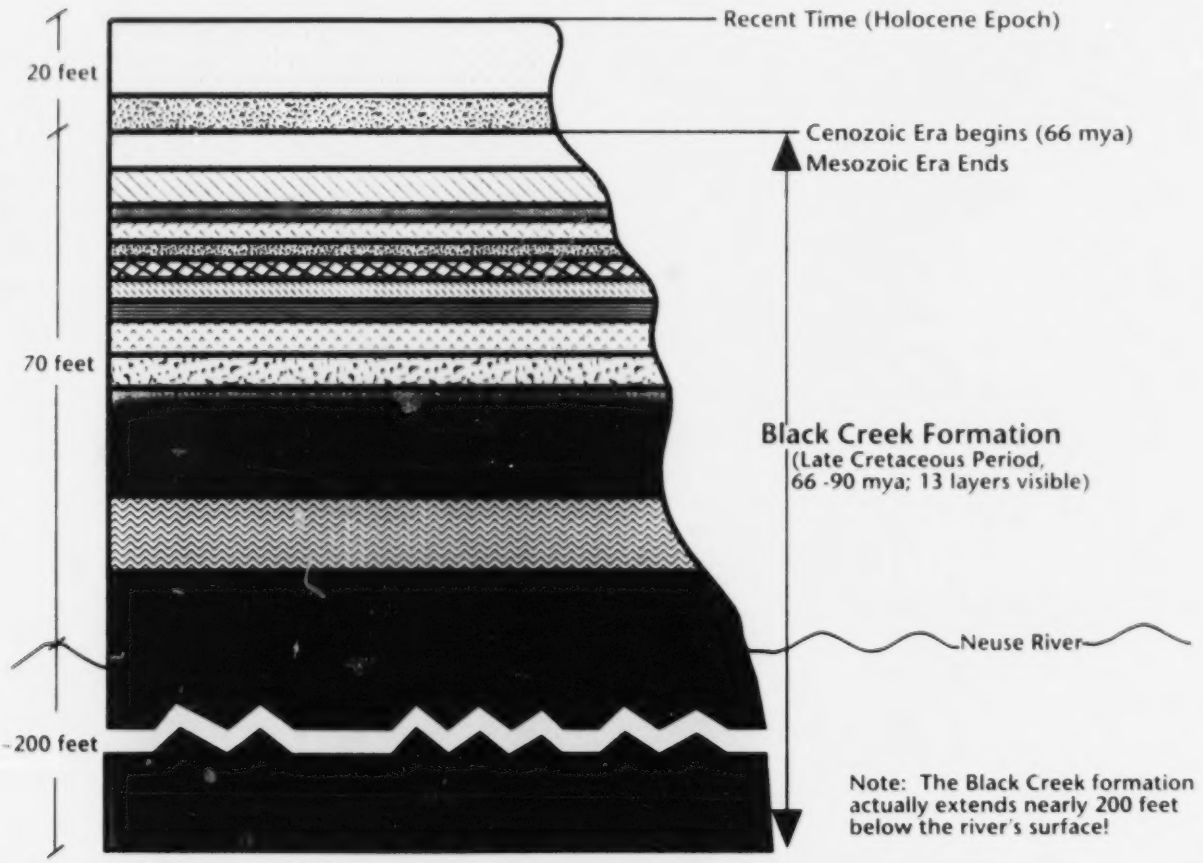

Recent Time (Holocene Epoch)
20 feet
Cenozoic Era begins (66 mya)
Mesozoic Era Ends
70 feet
Black Creek Formation
(Late Cretaceous Period,
66 -90 mya; 13 layers visible)
Neuse River
~200 feet
Note: The Black Creek formation actually extends nearly 200 feet below the river's surface!

Diagram of The Cliffs of The Neuse

Neuse River at Cliffs of the Neuse State Park

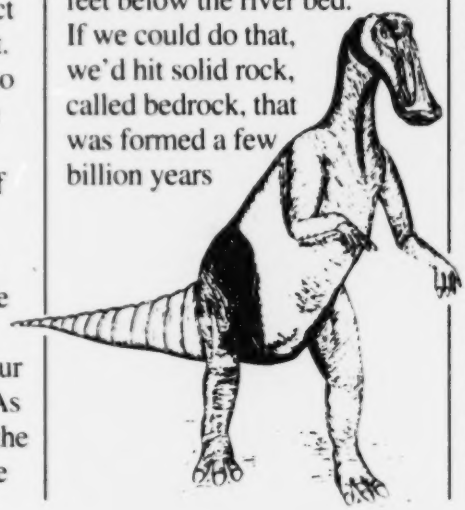
card will contain the information the student will need to teach the rest of the group about events that happened during the formation of the cliffs. Each kit will contain props that the students will use in their presentations.

2. Before starting, one group should remain at the top of the cliff and the other should move down to the 350-yard Trail.

3. The ranger will have marked the starting point for each group in the two separate areas. The teacher or ranger leading each group will direct the group to its starting point. Then he or she will explain to the students that they will be taking a short hike through time and building a model of the cliffs of the Neuse.

Suggested narrative: "Since we can not actually climb the cliffs without damaging them, we are going to take our 'climb' in our imagination. As we walk horizontally along the trail, we will imagine that we are climbing vertically up the cliffs. So, if we walk 15 feet along the trail, we will imagine we've climbed 15 feet up the cliffs. The layers in the cliffs were laid down millions of years ago when sand, clay and other sediments settled out of the water. The lower down a layer is, the older it is. The layers near the top of the cliffs were deposited very recently, in the past few million years."

"We will begin our journey way back in time by imagining we could tunnel down 276 feet below the river bed. If we could do that, we'd hit solid rock, called bedrock, that was formed a few billion years ago." (The teacher or ranger will now add the bedrock layer to the bottom of the Cliffs Model.)

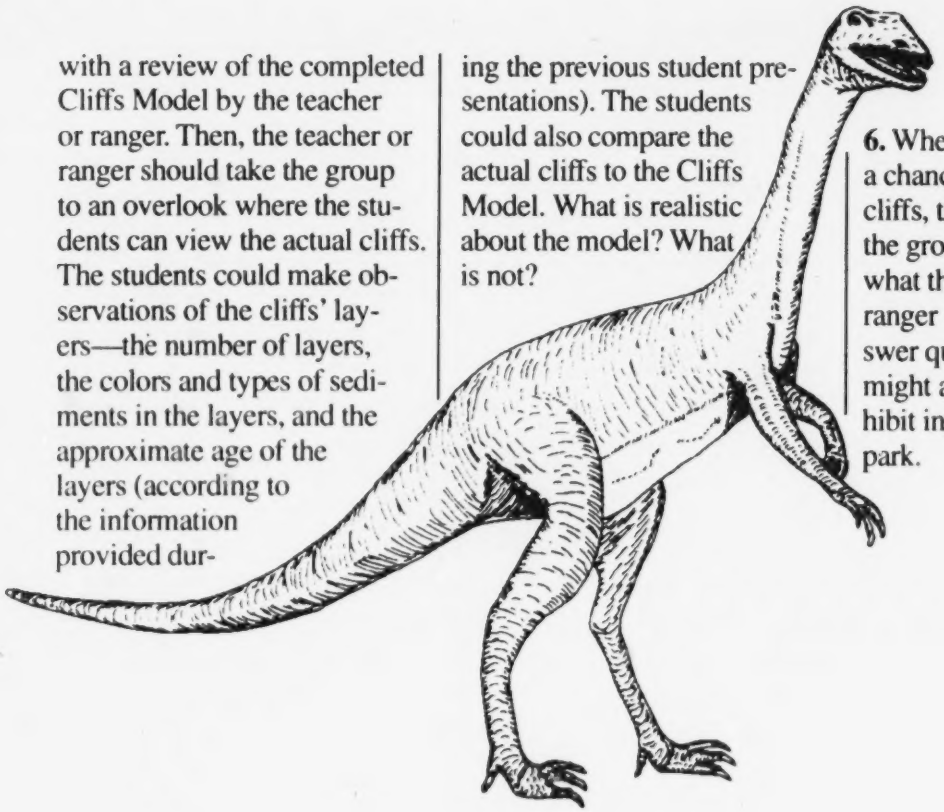


"In a few minutes, we are going to walk 276 feet along the trail to signify that we have climbed out of the Earth to the river's surface. As we climb out, we will have to pass through many layers of sediments that were laid down during the Mesozoic era. Let's hear about the Mesozoic era from the student who has card #1 before we make our climb."

4. After the student who has card #1 has made her presentation, the group will walk about 276 feet up the trail to another area (previously marked by the ranger). This marked area represents the bottom of the cliffs of the Neuse. The students with cards #2 and #3 will stretch the 90-foot rope along the trail from the marked point. The rope will represent the cliffs' height. In their journey up from the bedrock, the students now imagine that they are standing next to the oldest layers that can be seen at the bottom of the cliff (and the start of their rope).

5. The students will give their presentations, one at a time, and direct the group to move up the rope as explained on their cards. Each student will assist the teacher or ranger by adding something to the Cliffs Model at the end of his presentation. The imaginary climb up the cliffs will end with the student who has card #15 and

with a review of the completed Cliffs Model by the teacher or ranger. Then, the teacher or ranger should take the group to an overlook where the students can view the actual cliffs. The students could make observations of the cliffs' layers—the number of layers, the colors and types of sediments in the layers, and the approximate age of the layers (according to the information provided during the previous student presentations). The students could also compare the actual cliffs to the Cliffs Model. What is realistic about the model? What is not?



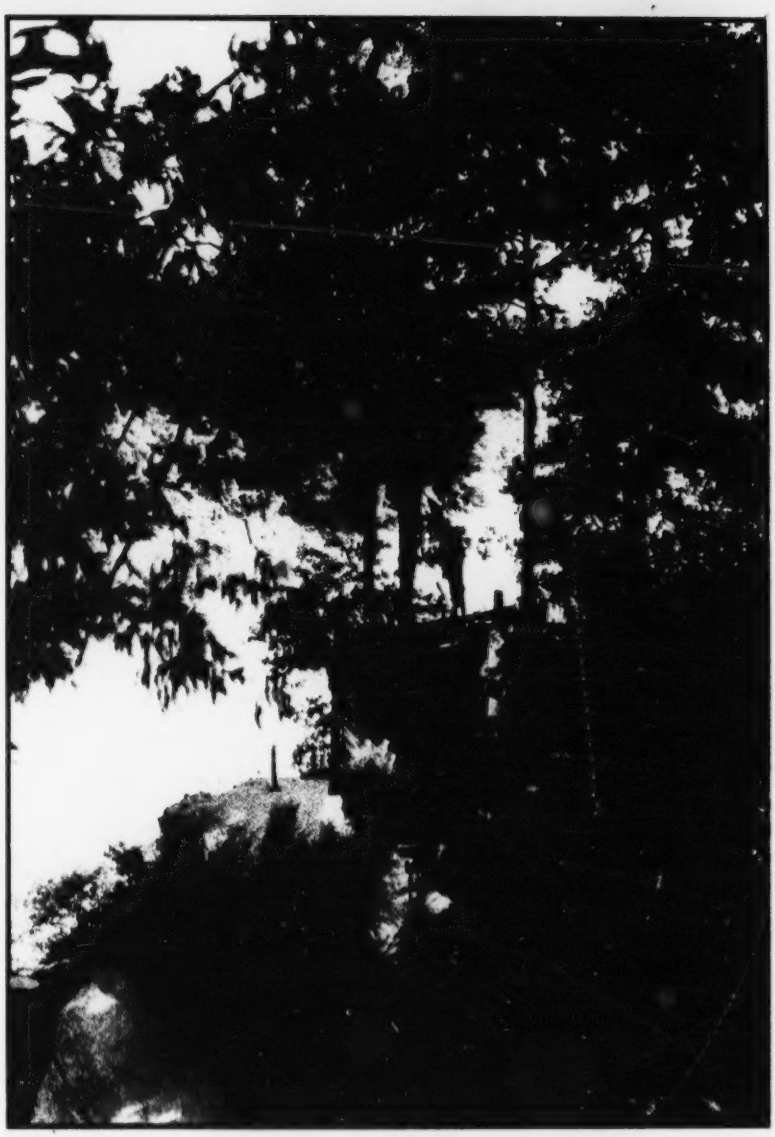
6. When both groups have had a chance to observe the actual cliffs, the teacher could bring the groups together to share what they have learned. A ranger will be available to answer questions and the group might also view the cliffs exhibit in the museum at the park.

Student's Information

Imagine Cliffs of the Neuse State Park, but 100 million years ago—the **Cretaceous period**.

Sounds of fear echo over the salt marsh as two small, ostrich-like **dinosaurs** frantically dart among the low-growing cycads and neopalms, fleeing from the powerful jaws of a relative of **Tyrannosaurus rex**. Nearby, closer to the brackish **estuary**, a huge, silent reptile stands 20 feet high. The duckbilled dinosaur peers among cypress trees and low ferns, poised and ready to retreat into the watery safety of the swamp where it can feed undisturbed on aquatic plants.

Toward the water's edge, salt marshes border a vast shallow sea. The estuary and marsh are slowly disappearing as the sea rises and creeps inland. Water-logged plants disintegrate into the sand; animals die and their remains are covered by the rising sea. Sand and **sediments** moved by the tides slowly settle out and cover their remains. By the end of this period many of this land's inhabitants will vanish in a mass extinction, even as the land itself disappears.



Mass extinction refers to times when huge numbers of different species of animals died out or disappeared. The reasons for these mass extinctions are not well understood. It is thought that climate changes and other environmental changes may have been partly responsible.

These mass extinctions did not happen overnight—they took place over long periods of time. **Fossil** records indicate that there were at least six mass extinctions and these help mark the endings of six time periods.

Some evidence of what happened here is preserved in the fossil record of the sands and clays exposed in the nearby cliffs of the Neuse. The time period described above is when most of the sediment in the cliffs' layers was deposited.

Over the next 60 million years many significant events took place, including the appearance of man and the **Ice**

Age. The Ice Age occurred during the **Pleistocene epoch** and featured at least four periods of **glacial** movement. Glacial movements were a result of climate change. When the temperature took a significant drop, the **glaciers** grew and advanced from the north and south poles. When the temperatures rose the glaciers retreated or melted back. The melting of the glaciers caused sea levels to rise, and the freezing or advancement caused sea levels to fall. After the last glacier retreated, the sea level rose and **erosion** began to shape the land as we know it today. One important thing to remember is that time does not stop and that

the same geologic processes that formed the Earth are still happening today. Evidence of these processes can be found today by looking at the muddy waters of the Neuse River, carrying eroded sediments to the river's delta by the sea.

According to the **geologic time** clock, about 4,500 million years have passed since the Earth was formed. During this time, land was formed, life began, mountains were shaped, seas rose and fell, the continents separated and moved, plants and animals evolved and died off, and climates changed. Quite simply, a lot has happened during the last 4,500 million years!

So before too much more time passes, let's spend some time exploring what happened during a relatively small period of geologic time at Cliffs of the Neuse.

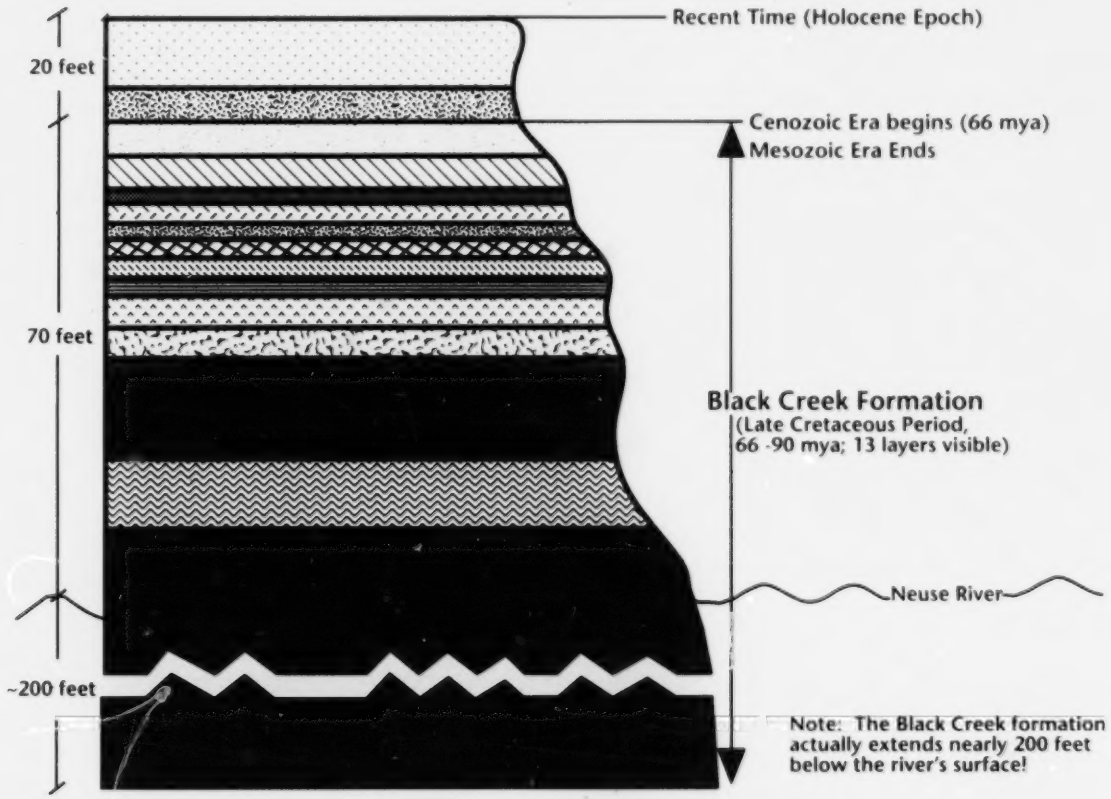


Diagram of The Cliffs of The Neuse

Layers of Time Information Card

Mesozoic Era

Student Instructions:

You will be talking about life in the Mesozoic era. To do this you will need the following items: fake snake, toy dinosaur, and the cut-out of a mountain range with "30,000 feet" on it. Ask the ranger or your teacher for these items. Once you have these items the ranger will tell you when to start reading. Instructions on when to use these items will appear in italics in the student's script. Pronunciations will be in parentheses.

Student Script:

Living during the Mesozoic (mez-a-zo'-ik) era was great, especially if you were a reptile. The Mesozoic era is also known as the "Age of Reptiles" because reptiles dominated the land, sea and sky. ***Hold up fake snake.*** This era began 240 million years ago and lasted about 175 million years. The Mesozoic contains three periods—Triassic, Jurassic, and Cretaceous (kri-tay'-shus). Dinosaurs appeared during the Triassic period and became dominant during the Cretaceous period when they roamed over the land and ate each other! Well, actually, most were plant eaters. ***Hold up toy dinosaur.*** During the Triassic period North America and Africa were connected as part of a huge supercontinent called Pangea (pan-jee'-a). The Appalachian mountains were located on the boundary between North America and Africa and may have been 30,000 feet high! ***Hold up mountain cutout.*** Near the end of the Triassic period, forces inside the Earth caused great fractures in the Earth's crust and North America and Africa were torn apart. OUCH! Water filled the area between the continents and created the Atlantic Ocean. During the Cretaceous period the ocean reached inland as far as Smithfield.

Student Instructions: (con't.)

Assist the teacher or ranger in adding a layer that represents the 276 feet of sediments that lie on top of the bedrock in the Cliffs Model. Then, lead your group 276 feet up the trail to the next marked point. When you arrive say:

We have now emerged above the surface of the Neuse River and are standing at the bottom of the cliffs of the Neuse.

Layers of Time Information Card

Cretaceous Period Begins

Student Instruction:

You will work with the student who has card #3 to stretch the 90-foot rope along the trail. You will be talking about the beginning of the Cretaceous period. To do this you will need the following items: snorkel and mask, picture of T-Rex, picture of tree fern. Ask your teacher or ranger for these items. Once you have them, the teacher or ranger will tell you when to start. Instructions on when to use these items will appear in italics in the student script. Pronunciations will be in parentheses.

Student Script:

The Cretaceous (kri-tay'-shus) period was one of the longest periods, lasting around 75 million years. The area we are in now was sometimes under the ocean as sea level rose and fell. ***Put on snorkel and mask, leave snorkel out of your mouth so you can talk.*** Flying reptiles called pterosaurs (ter´-o-sars) roamed the skies and a relative of *Tyrannosaurus rex*, a really foul-mannered dinosaur, stalked the gently rolling hills of the North Carolina coastal plain. If you didn't want to be lunch you kept out of its way. ***Hold up T-Rex.*** The climate was warm and humid, allowing tropical plants to flourish. One of the most common was a tree fern called Tempskya (temp-sky'-a). ***Hold up picture of tree fern.*** The latter part of the Cretaceous period is important to us because that is when most of the layers of sediments were laid down that would later be eroded away by the Neuse River to form the cliffs we see today. The 70-feet of layers we can see, plus another 200 feet of sediments below the river, belong to what geologists call The Black Creek Formation.

Ask your group - What is the name for the layers that make up 70 feet of the cliffs' height. (Answer: The Black Creek Formation) The next speaker will tell you more about this.

Layers of Time Information Card

Black Creek Formation

Student Instruction:

You will assist the student with card #2 to stretch the 90-foot rope along the trail, during your presentation. You will be talking about the Black Creek Formation. To do this you will need the following items: snorkel and mask, shark's tooth, liter bottle of water with sediments (shake this up before you start talking and set it down), picture of a marsh or delta. Ask the teacher or ranger for these items. Once you have these items the ranger will tell you when to start reading. Instructions on when to use these items will appear in italics in the student script. Pronunciations will be in parentheses.

Student Script:

The Black Creek Formation, exposed at Cliffs of the Neuse, was formed during the late Cretaceous (Kri-táy-shus) period, 66-90 mya. This formation consists of many layers of fine-grained sands, and alternating with thin layers of clay ranging from light gray to black. These layers were probably the result of this area being part of a large marsh or delta with shallow estuaries and tidal flats. ***Hold up picture of a marsh.*** Rivers and streams carried sediment from inland and deposited it in these shallow estuaries. The sea level rose ***(put on snorkel and mask)*** and fell several times during this period, rearranging the sand, mud, and clay sediments. Near the end of the Cretaceous (kri-tay'-shus) period the sea level fell. ***Take off snorkel and mask.*** The layers of sediments left behind would be buried over the following years, only to be exposed by erosion millions of years later by the Neuse River. It took about 30 million years to form 13 of these layers. ***Hold up bottle of water/sediment to see if any layers are visible.*** The sediments in this bottle have settled out into layers. This is a much faster and simplified process of what occurred at Cliffs of the Neuse. Dinosaurs continued to diversify and develop and trees like sassafras, magnolia and maple appeared. Sharks were very abundant ***(hold up shark's tooth)*** as were shellfish, corals and sponges that thrived in the shallow seas.

Ask your group - How long did it take to form the 13 layers of the Black Creek Formation that are visible today at Cliffs of the Neuse State Park? (Answer: about 30 million years)

Layers of Time Information Card

Dryptosaurus

Student Instruction:

You will need the replica of a *Dryptosaurus*. Ask the teacher or ranger for this item. Once you have this item your teacher or ranger will tell you when to start. Instructions on when to use this item will appear in italics in the student script. Pronunciations will be in parentheses.

Student Script:

Fossil records indicate that *Dryptosaurus* (drype'-to-sar-us) was one of at least four dinosaurs that roamed the area during the Cretaceous (kri-táy-shus) period. This dinosaur was a medium-sized carnivore with a body about 33 feet long. *Dryptosaurus* sported a short, muscular neck and big powerful hind legs. This predator used its long tail to balance on its hind legs and would leap upon its prey slashing it to bits with sharp claws and then tearing off huge bloody chunks of flesh with its sharp teeth, YUM! YUM! ***Show the class the replica of Dryptosaurus and point out the huge back legs and long tail.***

Student Instruction: (con't)

Add a replica of this animal to the Cliffs Model.

Layers of Time Information Card

Duckbilled Dinosaur

Student Instruction:

You will need the replica of the duckbilled dinosaur. Ask the teacher or ranger for this item. Once you have this item the teacher or ranger will tell you when to start. Instructions on when to use this item will appear in italics in the student's script. Pronunciations will be in parentheses.

Student Script:

This appropriately-named reptile, the duckbilled dinosaur, may have weighed 4,000 pounds and stood approximately 10 feet tall. This dinosaur probably lived in or very close to the swamps and estuaries that covered the cliffs area, and ate aquatic plants. It's likely that they walked on their hind legs and used their tails for balance. ***Show the class the replica and point out the duck-like bill.*** This type of bill was suited for munching plants, not other animals.

Student Instruction: (con't)

Add a replica of this animal to the Cliffs Model.

Layers of Time Information Card

Hollow-boned Coelurosaur

Student Instruction:

You will need the replica of the coelurosaur. Ask the teacher or ranger for this item. Once you have this item the teacher or ranger will tell you when to start. Instructions on when to use this item will appear in italics in the student script. Pronunciations will be in parentheses.

Student Script:

Ostrich-like best describes how this dinosaur appeared. It was less than 16 feet long and stood about 7 feet high. The mouth had a small, flattened, hard beak that was used to eat fruits, plants, insects and maybe small animals. ***Show the class the replica of the hollow-boned coelurosaur (see-lur'-o-sar).***

Student Instruction: (con't)

Add a replica of this animal to the Cliffs Model.

Layers of Time Information Card

Mosasaur

Student Instructions:

You will need the replica of the mosasaur. Ask the teacher or ranger for this item. Once you have this item the teacher or ranger will tell you when to start. Instructions for when to use this item will appear in italics in the student script. Pronunciations will be in parentheses.

Student Script:

Mosasaurs (mo'-sa-sars) were marine lizards. They grew to lengths of 29.5 feet. Their sharp teeth and strong tails equipped them for eating fish and a variety of other vertebrates. They lived in lagoons and appeared to be one of the most ferocious marine lizards, sort of a prehistoric JAWS. ***Show the replica of the mosasaur.***

Student Instruction: (con't)

Add a replica of this animal to the Cliffs Model.

Layers of Time Information Card

Gigantic Crocodile and Ghost Sharks

Student Instruction:

You will be talking about two animals that lived during the time when the Black Creek Formation was formed. To do so you will need the following items: toy shark and toy crocodile. Ask the teacher or ranger for these items. Once you have these items the teacher or ranger will tell you when to start. Instructions on when to use these items will appear in italics in the student script. Pronunciations will be in parentheses.

Student Script:

Fossil records show that a very large crocodile was slithering and swimming around the cliffs of the Neuse during the late Cretaceous (kri-tay'-shus). It is named *Deinosuchus* (dye-nos'-a-kus) and grew to 39 feet in length and ate anything it wanted to! ***Show toy crocodile.*** Sharks were abundant, with many different species present at this time. Among the most common were the ghost sharks, which grew to a length of 13 feet. ***Show toy shark.***

Student Instruction: (con't)

Add replicas of each of these animals to the Cliffs Model. Move your group 70 feet to the next red mark on the rope.

Layers of Time Information Card

Cretaceous Period Ends

Student Instruction:

You will be talking about the end of the Cretaceous period. To do this you will need the following items: snorkel and mask, picture of a dinosaur with EXTINCT written across it, and a cutout of the number "50%." Ask the teacher or ranger for these items. Once you have them the teacher or ranger will tell you when to start. Instructions on when to use these items will appear in italics in the student script. Pronunciations will be in parentheses.

Student Script:

Towards the end of the Cretaceous (kri-tay'-shus) period the sea level rose once more to cover the Black Creek Formation with another layer of marine sediments. ***Put on snorkel & mask.*** Then, the sea withdrew from eastern North Carolina and streams and rivers went to work eroding away the newly exposed surface. In North Carolina and throughout the world, the end of the Cretaceous was marked by a significant mass extinction where over 50% (***hold up the number "50%"***) of all species became extinct. All the dinosaurs became extinct. ***Hold up a picture of dinosaur with EXTINCT stamped across it.***

Student Instruction: (con't)

Assist the teacher or ranger in placing the 13 layers of sediment formed during the Cretaceous period into the Cliffs Model. You will also help the teacher put a fossil in between each layer. Then say:

This represents the Black Creek Formation visible today at the Cliffs of the Neuse. These layers account for about 70 feet of the cliffs' total height. Remember that 200 more feet of the Black Creek Formation exists below the Neuse River. It took about 30 million years for all these layers to be deposited.

Student Instruction: (con't)

Ask the teacher or ranger to explain mass extinction before you go on to the next student presenter.

Layers of Time Information Card

Cenozoic Era

Student Instruction:

You will be talking about the Cenozoic era. To do this you will need the following items: a cutout of the number "66 million," snorkel and mask. Ask the teacher or ranger for these items. Once you have these items the teacher or ranger will tell you when to start. Instructions on when to use these items will appear in italics in the student script. Pronunciations will be in parentheses.

Student Script:

Known as the "Era of Recent Life," the Cenozoic (see-na-zo'-ik) era covers the time from 66 million years ago (***hold up "66 million"***) to the present. This era contains two periods—the Tertiary (ter' -she-ary) and the Quaternary (kwa-ter'-nary). This era contains the most complete geological record of all the eras. The sea rose and fell several times. ***Put on, and then take off, snorkel and mask.*** As the sea level rose and fell, so did the shoreline in North Carolina. Evidence of these events can be seen by the presence of scarps or terraces that formed from sediments left behind by the sea. The world famous Yorktown Formation was deposited. This formation is well known for the abundance and variety of fossils preserved in its layers. Move up to the next red mark on the rope.

Student Instruction: (con't)

Lead your group to the next red mark on the rope.

Layers of Time Information Card

Tertiary Period

Student Instruction:

You will be talking about the Tertiary period. To do this you will need the following items: snorkel and mask, Hawaiian shirt, cardboard horse shoe. Ask your teacher or ranger for these items. Once you have them the teacher or ranger will tell you when to start. Instructions on when to use these items will appear in italics in the student's script. Pronunciations will be in parentheses.

Student Script:

Most of the remaining 20 feet of the exposed cliffs' layers were deposited and reworked during the Tertiary (ter'-she-ary) period. Evidence suggests that the water rose higher than it had in the past, pushing the edge of the ocean inland to cover all of the coastal plain. ***Put on snorkel and mask.*** The climate was sub-tropical. ***Put on Hawaiian shirt.*** Fish thrived in the shallow seas, as did shellfish and other marine life. On land, new species of mammals continued to rapidly increase. The first appearance of condylarthys (con-dill-ar'-this), the forerunners of hoofed mammals, appeared. ***Show cardboard horseshoe.*** Squirrel-like primates and marsupials show up in the fossil records. For this reason, the entire period is sometimes referred to as the Age of Mammals.

Layers of Time Information Card

Tertiary Animals

Student Instruction:

You will be talking about animals from the Tertiary period. To do this you will need the following items: oyster shell, and 100-foot measuring tape. Ask your teacher or ranger for these items. Once you have them, the teacher or ranger will tell you when to start. Instructions on when to use these items appear in italics in the student script. Pronunciations will be in parentheses.

Student Script:

Gigantic oysters grew up to a foot long ***(hold up an oyster shell)*** in these shallow seas. The largest shark to ever swim in North Carolina's waters, the 70-foot-long *Carcharodon* (kar-ker'-a-don) swam the seas and a giant false-toothed pelican, a bird with a wingspan of 20 feet and weighing 88 pounds, patrolled the air during the Tertiary (ter'-she-ary) period.

Student Instruction: (con't)

Ask another student to hold one end of the measuring tape and pull out 70 feet to show how big the *Carchardon* shark was. Then pull the tape in to 20 feet to show the wingspan of the false-toothed pelican. Put a fossil representative of these animals in the Cliffs Model.

Layers of Time Information Card

Eocene Epoch

Student Instruction:

You will be talking about the Eocene epoch. To do this you will need the following items; toy horse, and sketch of a cow in the sea. Ask your teacher or ranger for these items. Once you have them the teacher or ranger will tell you when to start. Instructions on when to use these items will appear in italics in the student's script. Pronunciations will be in parentheses.

Student Script:

The Eocene (ee'-o-seen) epoch occurred about 54 million years ago and is known as the "Dawn of Recent Life." The sea-cow, a seaweed-feeding mammal, appeared. ***Show the sketch of the sea-cow.*** The sea-cow really didn't look like this. It probably looked more like today's manatee. Another new mammal arrived on the scene, the first horse, *Eohippus* (ee-o-hip'-us), a four-toed animal. ***Show toy horse.*** The sea moved inland again and covered the land with heavy breaking waves (surf's up dude!) that washed away evidence of this time period farther inland. A two to three foot layer in the upper part of the cliff was formed during this period.

Student Instruction: (con't)

Add fossil representatives of the two Eocene animals and a layer of sediment to the Cliffs Model. Then, move your group to the next red mark on the rope.

Layers of Time Information Card

Quaternary Period

Student Instruction:

You will be talking about events that took place in the Quaternary period. To do this you will need the following items: snorkel and mask, winter parka, gloves, winter hat, and a poster of North Carolina showing sea level at Wilson Mills. Ask your teacher or ranger for these items. Once you have them the teacher or ranger will tell you when to start. Instructions on when to use these items will appear in italics in the student script. Pronunciations will be in parentheses.

Student Script:

Repeated changes in climate from cold to hot, in turn, caused the polar ice caps to melt or freeze, which, in turn, caused the sea level to rise and fall several times during the Quaternary (kwa-ter'-nary) period. This sea level rise is beginning to sound like a broken record isn't it? This sea level rise is beginning to sound like a broken record isn't it? ***Put on and take off mask and snorkel.*** During extended cold periods the polar ice caps would spread out from Earth's poles. These glaciers never reached North Carolina, but they did cause our climate to be cool, even downright cold. ***Put on winter parka, hat and gloves.*** At one point the climate warmed, melting the polar ice and sending the sea as far inland as Wilson's Mills in Johnston County. This means once again that the cliffs were underwater. ***Show the poster of North Carolina; point out the sea level at Wilson's Mills.*** Sediments from this period make up the upper few feet of the cliffs.

Student Instruction: (con't)

Add the final "layer" to the Cliffs Model.

Layers of Time Information Card

Pleistocene and Holocene Epochs

Student Instruction:

You will be talking about the Pleistocene and Holocene epochs. To do this you will need the following items: a toy figure of a man, a toy figure of a woman, cardboard cut-out of a wooly mammoth, a replica of a camel, and an aerial photo of our outer banks. Ask your teacher or ranger for these items. Once you have them your teacher or ranger will tell you when to start. Instructions on when to use these items will appear in italics in the student script. Pronunciations will be in parentheses.

Student Script:

The Quaternary (kwa-ter'-nary) period has two epochs—the Pleistocene (ply-sta-seen) and Holocene(ho'-lo-seen). Everyone here should be extremely interested in these two epochs for two reasons--the first reason being that the first man, and the first woman, appeared during the Pleistocene (ply'-sta-seen). ***Show toy figures of man and woman.*** The second reason being that the Holocene (ho'-lo-seen) epoch is the present time period we are in, even as we speak. The good thing about the Holocene epoch is that it has not ended yet! North Carolina appears to have been a transition zone during the glacial periods, a place where cold weather animals like the wooly mammoth mingled with camels and other animals that preferred warmer weather. ***Show wooly mammoth and camel.*** The last major event to take place was the formation of our coastal barrier islands or outer banks which took place around 18,000 years ago. ***Show aerial photo of outer banks.***

Student Instruction: (con't)

Move your group to the end of the rope.

Ask your teacher to read the following quote: " We are the ephemeral portion of our partnership with the Earth. If we ignore the lessons our geological heritage teaches, we are the ones who will suffer. The rocks and hills of the Carolinas have a message for us. They are saying, 'We were millions of years in the making and we will be here long after the last human is gone. Take care how you treat us, lest you shorten your stay on this planet and become extinct before your time.'"

The teacher may want to define "ephemeral" to the students. The teacher or ranger will briefly review the Cliffs Model, then lead the group to the overlook to view the real cliffs.

Post-Visit Activity #1 Life at the Cliffs, Then and Now

Curriculum Objectives:

Grade 6

- Communication Skills: listening, reading, vocabulary and viewing comprehension
- Library/Media Skills: work independently and creatively in preparing assignments
- Social Studies: gather, organize and analyze information, draw conclusions
- Science: conservation, preservation and wise use of natural resources

Grade 7

- Communication Skills: listening, reading, vocabulary and viewing comprehension
- Library/Media Skills: work independently and creatively in preparing assignments
- Social Studies: gather, organize and analyze information, draw conclusions
- Science: conservation, preservation and wise use of natural resources

Grade 8

- Communication Skills: listening, reading, vocabulary and viewing comprehension
- Library/Media Skills: work independently and creatively in preparing assignments
- Social Studies: gather, organize and analyze information, draw conclusions
- Science: conservation, preservation and wise use of natural resources

Location: Classroom

Group Size:
30 students - may want to work in pairs.

Estimated Time: 30 minutes

Appropriate Season: Any

Materials:
Provided by the educator:
Per student: one copy each of "Life at the Cliffs, Then and Now" word search and "Introduction to Cliffs of the Neuse State Park" (pages 1.2 and 1.3 only).

Major Concepts:

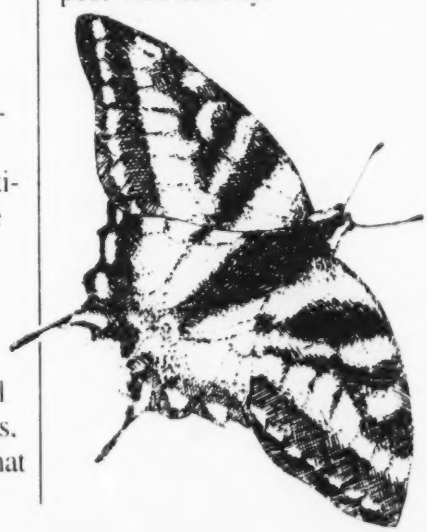
- Geologic terms
- Plants and animals
- Conservation and stewardship

Objectives:

- Become familiar with geologic terms and plant and animal names that are pertinent to Cliffs of the Neuse State Park.
- Explain why Cliffs of the Neuse was set aside as a state park.
- List two unique geological features, two unique plants, and two unique animals that exist within the park.

Educator's Information:

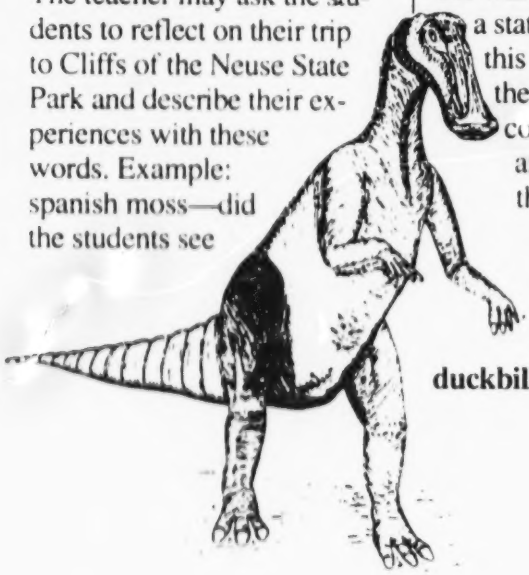
This activity will reinforce some of the terms and concepts that the students learned in previous activities. It will also introduce the students to the history of the park and to the unique plants and animals living there today. Students may wish to refer to Student's Information sheets from previous activities to complete this post-visit activity.



Instructions:

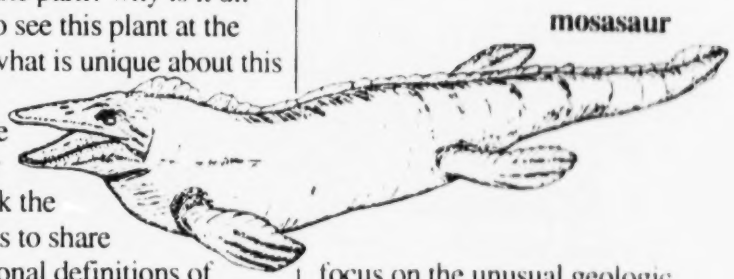
1. Hand out copies of the "Life at the Cliffs, Then and Now" word search. Have students try to locate all 25 words. Words may appear across, up and down, and diagonally.

2. Hand out copies of "Introduction to Cliffs of the Neuse State Park." Students should read pages 1.2 and 1.3 of the Introduction and underline words on this sheet that they also found in the word search. The teacher may ask the students to reflect on their trip to Cliffs of the Neuse State Park and describe their experiences with these words. Example: spanish moss—did the students see any at the park? why is it unusual to see this plant at the park? what is unique about this plant? etc. The teacher may ask the students to share operational definitions of other words from the word search, especially those dealing with geology and geologic time.



duckbilled dinosaur

3. Finally ask students to give reasons why Cliffs of the Neuse was originally set aside as a state park. Why should this area be preserved in the future? (Students could list unique plants and animals that live at the park, or they could focus on the unusual geologic features of the park and surrounding area.) The teacher could ask the students, using as many of the words from the word search as possible, to write an essay explaining why the park should be preserved. Or, the teacher may ask the students to write stories describing their actual trip to the park, or an imaginary trip to the park during a specific geologic period in the past.



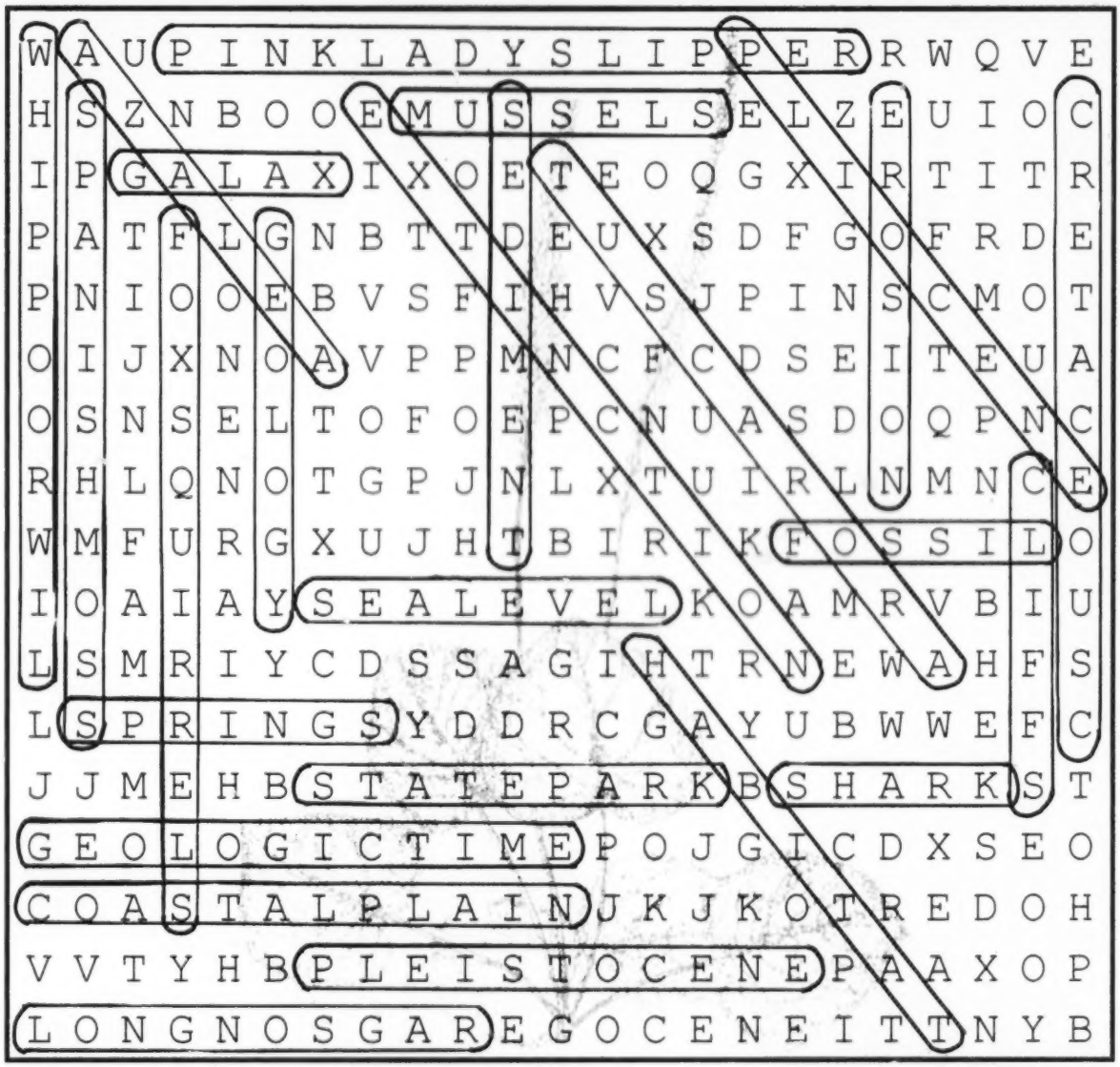
mosasaur

Life at the Cliffs, Then and Now Word Search

W A U P I N K L A D Y S L I P P E R R W Q V E
H S Z N B O O E M U S S E L S E L Z E U I O C
I P G A L A X I X O E T E O Q G X I R T I T R
P A T F L G N B T T D E U X S D F G O F R D E
P N I O O E B V S F I H V S J P I N S C M O T
O I J X N O A V P P M N C F C D S E I T E U A
O S N S E L T O F O E P C N U A S D O Q P N C
R H L Q N O T G P J N L X T U I R L N M N C E
W M F U R G X U J H T B I R I K F O S S I L O
I O A I A Y S E A L E V E L K O A M R V B I U
L S M R I Y C D S S A G I H T R N E W A H F S
L S P R I N G S Y D D R C G A Y U B W W E F C
J J M E H B S T A T E P A R K B S H A R K S T
G E O L O G I C T I M E P O J G I C D X S E O
C O A S T A L P L A I N J K J K O T R E D O H
V V T Y H B P L E I S T O C E N E P A A X O P
L O N G N O S E G A R G O C E N E I T T N Y B

EXTINCTION
PLEISTOCENE
PLIOCENE
FOX SQUIRRELS
CLIFFS
TUSCARORA
CRETACEOUS
AZALEA
LONGNOSE GAR
STATE PARK
EROSION
MUSSELS
SHARK
SEDIMENT
SEA LEVEL
GEOLOGIC TIME
SPRINGS
WHIP-POOR-WILL
GALAX
SPANISH MOSS
GEOLOGY
HABITAT
FOSSIL
COASTAL PLAIN
PINK LADYSLIPPER

Life at the Cliffs, Then and Now Word Search Answer Sheet


W A U P I N K L A D Y S L I P P E R R W Q V E
H S Z N B O O E M U S S E L S E L Z E U I O C
I P G A L A X I X O E T E O Q G X I R T I T R
P A T F L G N B T T D E U X S D F G O F R D E
P N I O O E B V S F I H V S J P I N S C M O T
O I J X N O A V P P M N C F C D S E I T E U A
O S N S E L T O F O E P C N U A S D O Q P N C
R H L Q N O T G P J N L X T U I R L N M N C E
W M F U R G X U J H T B I R I K F O S S I L O
I O A I A Y S E A L E V E L K O A M R V B I U
L S M R I Y C D S S A G I H T R N E W A H F S
L S P R I N G S Y D D R C G A Y U B W W E F C
J J M E H B S T A T E P A R K B S H A R K S T
G E O L O G I C T I M E P O J G I C D X S E O
C O A S T A L P L A I N J K J K O T R E D O H
V V T Y H B P L E I S T O C E N E P A A X O P
L O N G N O S G A R E G O C E N E I T T N Y B

EXTINCTION
PLEISTOCENE
PLIOCENE
FOX SQUIRRELS
CLIFFS
TUSCARORA
CRETACEOUS
AZALEA
LONGNOSE GAR
STATE PARK
EROSION
MUSSELS
SHARK
SEDIMENT
SEA LEVEL
GEOLOGIC TIME
SPRINGS
WHIP-POOR-WILL
GALAX
SPANISH MOSS
GEOLOGY
HABITAT
FOSSIL
COASTAL PLAIN
PINK LADYSLIPPER

VOCABULARY

Australopithecines (aw-stray-lo-pith'-a-seens) - Any of several extinct manlike primates from the genus *Australopithecus*, *Paranthropus*, or *Zinjanthropus*. Known from fossil remains during the Pleistocene found mainly from southern Africa. *Australopithecines* is from the Latin *Australopithecus* or "southern ape."

Black Creek Formation - Name for the layers of sediments that are exposed at Cliffs of the Neuse. This formation is thought to be part of a large delta that once grew southeastward off the coast of North Carolina and South Carolina.

Cambrian - The first period of the Paleozoic era, beginning 570 million years ago.

Cenozoic (see-na-zo'-ik) - The youngest era, containing two (sometimes three) periods and seven epochs. The Cenozoic era covers the time from 66.4 mya to the present.

Coastal plain - The generally flat land area between the ocean and the Piedmont, blanketed by Mesozoic and Cenozoic sediments.

Cretaceous (kri-tay'-shus) - The third and youngest of the three Mesozoic periods. Dinosaurs became extinct at the end of this period.

Delta - A usually fan-shaped accumulation of sedimentary deposits at the mouth of a river.

Dinosaur - Any member of the extinct reptile orders Saurischia and Ornithischia. From the Greek which means "terrible lizard."

Eocene (ee'-o-seen) - An epoch of the Tertiary period, lasting from approximately 54.6 mya to 36.6 mya.

Epoch (ee'-pok) - A geological unit of time; a division of a geologic period.

Eras - The longest geological division of time. There are five eras.

Erosion - The group of natural processes including weathering, dissolution, abrasion, corrosion and transportation by which earth, rock or sediments are removed from any part of the Earth's surface.

Estuarine (es'-tyu-ar-een) - Pertaining to an estuary, where fresh water comes into contact with seawater.

Fault - A break in the continuity of the Earth's crust, caused by shifting plates or layers below the Earth's surface.

Formation - Referring to a layered geological unit consisting of a distinct, usually tabular body of rock or sediment that is mappable at the Earth's surface or traceable in the subsurface.

Fossil - Any preserved remain, impression or trace of a plant or animal from a former geologic age.

Fossilization - Any of several processes by which plant and animal remains or traces of animal activity are buried and preserved, either whole or in part.

Geology - The science of the Earth, how it was formed, what it is made of, its history and the changes that take place on it and in it.

Geologic time - Units of time, divided into eras, periods, and epochs to describe a specific time in the Earth's past.

Geologist - A person who studies geology.

Glacier - A huge mass of laterally limited, moving ice originating from compacted snow.

Glacial - Pertaining to or derived from a glacier.

Holocene (ho'-lo-seen) - The youngest and present epoch, located in the Quaternary period, beginning approximately 10,000 years ago.

Homo sapiens (ho-mo say'-pee-ens) - The taxonomic designation for modern man.

Ice Age - The time during the Pleistocene epoch, when there were several major glacial advances.

Key - An ordered list of significant characteristics of a group of organisms or things; used to identify unknown species or things.

Jurassic - The second period of the Mesozoic era, characterized by the existence of dinosaurs and the appearance of primitive birds and mammals.

Mesozoic (mez-a-zo'-ik) - An era that designates a time period from about 230 mya to about 65 mya.

Miocene (my'-o-seen) - An epoch in the Tertiary period, lasting from approximately 23.7 to 5.3 mya.

mya - Millions of Years Ago.

Neogene (nee'-o-jeen) - A division within the Tertiary period that contains the Miocene and Pliocene epochs.

Oligocene (o'-lig-o-seen) - An epoch of the Tertiary period, lasting from approximately 36.6 to 23.7 million years ago.

Paleocene (pay'-lee-o-seen) - The oldest epoch in the Tertiary period, lasting from approximately 66.4 to 57.4 mya.

Paleogene (pay'-lee-o-jeen) - A division within the Tertiary period, which includes the Paleocene, Eocene, and Oligocene epochs.

Period - A geologic time period. Periods are contained in eras and, in turn, periods contain epochs.

Piedmont - In North Carolina, the land between the foothills in the mountains and the coastal plain.

Pleistocene (ply'-sta-seen) - An epoch in the Quaternary period.

Pliocene (ply'-o-seen) - The youngest epoch in the Tertiary period.

Prehistoric - Pertaining to the time before the advent of written records, generally considered to be older than 5,000 years B.C.E.

Quaternary (kwa-ter'-nary) - The current period of the Cenozoic era.

Sandstone - A sedimentary rock composed chiefly of sand-sized quartz grains.

Scarp - A geologic term referring to a land formation that was caused by rising and falling prehistoric oceans that laid down or eroded away the land leaving a distinct slope or change in elevation.

Sediment - Solid particles such as sand, gravel, clay, and soil that settle to the bottom of a body of water.

Sedimentary rock - A rock made by the compaction or cementing of sediments in layers. Minerals, brought in by seeping water, eventually cement the layers together.

Sedimentation - The process of accumulation of sediment.

Tertiary - A period within the Cenozoic era. This period is sometimes divided into the Paleogene and the Neogene periods.

Triassic (try-ass'-ik) - The earliest period in the Mesozoic era.

References

Beyer, Fred. 1991. *North Carolina - The Years Before Man. A Geologic History.* Durham, NC: Carolina Academic Press.

Carpenter, P. Albert, III. (editor). 1989. *A Geological Guide to North Carolina State Parks.* Bulletin 91. Raleigh, NC. For more information, contact NC Geological Survey Section, Division of Land Resources, PO Box 27687, Raleigh NC 27611.

Cliffs of the Neuse State Park. Park geology files. For more information, contact Cliffs of the Neuse State Park, 345-B Park Entrance Road, Seven Springs, NC 28578.

Glut, Donald F. 1982. *New Dinosaur Dictionary.* Secaucus, NJ: Citadel Press.

SCHEDULING WORKSHEET

For office use only:
Date request received_____ Request received by_____

1) Name of group (school) _____

2) Contact person _____ _____
name phone (work) (home)

_____
address

3) Day/date/time of requested program _____

4) Program desired and program length _____

5) Meeting place _____

6) Time of arrival at park _____ Time of departure from park _____

7) Number of students _____ Age range (grade) _____
(Note: A maximum of 30 participants is recommended.)

8) Number of chaperones _____
(Note: One adult for every 10 students is recommended.)

9) Areas of special emphasis _____

10) Special considerations of group (e.g. allergies, health concerns, physical limitations)_____
_____

11) Have you or your group participated in park programs before? If yes, please indicate previous programs attended: _____
_____

12) Are parental permission forms required? _____ If yes, please use the Parental Permission form on page 8.2.

I, _____, have read the entire Environmental Education Learning Experience and understand and agree to all the conditions within it.

Return to: Cliffs of the Neuse State Park
Route 2, Box 50
Seven Springs, NC 28578

Fax: (919) 778-9589

PARENTAL PERMISSION FORM

Dear Parent:

Your child will soon be involved in an exciting learning adventure - an environmental education experience at **Cliffs of the Neuse State Park**. Studies have shown that "hands-on" learning improves children's attitudes and performance in a broad range of school subjects.

In order to make your child's visit to "nature's classroom" as safe as possible we ask that you provide the following information and sign at the bottom. Please note that insects, poison ivy and other potential risks are a natural part of any outdoor setting. We advise that children bring appropriate clothing (long pants, rain gear, sturdy shoes) for their planned activities.

Child's name _____

Does your child:

- Have an allergy to bee stings or insect bites?_____
  If so, please have them bring their medication and stress that they, or the group leader, be able to administer it.

- Have other allergies? _____

- Have any other health problems we should be aware of?_____
  _____ _____ _____

- In case of an emergency, I give permission for my child to be treated by the attending physician. I understand that I would be notified as soon as possible.

_____ _____
Parent's signature date

Parent's name _____ Home phone _____
(please print) Work phone _____

Family Physician's name _____ phone _____

Alternate Emergency Contact

Name_____ phone _____

57

NORTH CAROLINA PARKS & RECREATION
PROGRAM EVALUATION

Please take a few moments to evaluate the program(s) you received. This will help us improve our service to you in the future.

1. Program title(s) _____ Date _____
   Program leader(s) _____

2. What part of the program(s) did you find the most interesting and useful? _____
   _____

3. What part(s) did you find the least interesting and useful? _____
   _____

4. What can we do to improve the program(s)? _____
   _____
   _____

5. General comments _____
   _____
   _____
   _____

LEADERS OF SCHOOL GROUPS AND OTHER ORGANIZED YOUTH GROUPS
PLEASE ANSWER THESE ADDITIONAL QUESTIONS:

6. Group (school) name _____

7. Did the program(s) meet the stated objectives or curriculum needs? _____
   If not, why? _____
   _____

Please return the completed form to park staff. Thank you.

Cliffs of the Neuse State Park
Route 2, Box 50
Seven Springs, NC 28578
Fax: (919) 778-9589